

**THE CENTER OF GRAVITY CONCEPT: A KNOWLEDGE ENGINEERING APPROACH TO
IMPROVED UNDERSTANDING AND APPLICATION**

A thesis presented to the Faculty of the U.S. Army
Command and General Staff College in partial
fulfillment of the requirements for the
degree

MASTER OF MILITARY ART AND SCIENCE

by

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B.S., U.S. Military Academy, West Point, New York, 1984

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MASTER OF MILITARY ART AND SCIENCE

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ABSTRACT

THE CENTER OF GRAVITY CONCEPT: A KNOWLEDGE ENGINEERING APPROACH TO
IMPROVED UNDERSTANDING AND APPLICATION by CPT (P) Timothy J.
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This thesis investigates ways to contend with Carl von Clausewitz's center of gravity concept. It describes the concept's importance and the alarming degree of confusion regarding its application. The thesis describes the use of knowledge engineering techniques to study the thought processes that selected War College instructors use when applying the center of gravity concept. It synthesizes the best approaches to center of gravity determination from this research into a methodology.

The study finds that while war is very complex, nonlinear, and dynamic and is impacted by a myriad of important variables that planners must consider, the strategic center of gravity is usually some aspect of that which controls the state, alliance, coalition, or group. The operational center of gravity is usually some aspect of the military force(s). The strategic center of gravity is usually found at or above the strategic *national* level while the operational center of gravity is usually found at the strategic *theater* level. The study also describes the dynamic linkages between relative interests, objectives, time, and centers of gravity.

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CHAPTER ONE

INTRODUCTION

This thesis focuses on ways of contending with Carl von Clausewitz's center of gravity concept. This concept is now a prominent part of both joint and Army doctrine; unfortunately, it is poorly understood and inconsistently applied. Many students and practitioners do not apply any form of rational appraisal of the strategic and theater environments enroute to center of gravity determination. If the center of gravity concept is "the basis for devising both national military and theater strategies,"¹ the military needs to clarify the concept and provide a useful framework for applying it.

This thesis specifically explores the question: "Using knowledge engineering techniques, is it possible to distill discernible thought patterns from selected strategists and professional literature to create a useful methodology for applying the center of gravity concept?" It describes one of the first attempts to use artificial intelligence and knowledge engineering techniques to help isolate and model strategic level thought processes. This thesis rests on research conducted by the author between October 1993 and June 1994 as part of a U.S. Army War College Center for Strategic Leadership project. It summarizes research findings from interviews and literature and attempts to construct a methodology for center of gravity determination.

This thesis contends that while there are no simple solutions or formulas, the military does not have to rely exclusively on intuition to apply the center of gravity concept. The military can use the knowledge engineering techniques described in Chapter Three to deduce a logic flow for center of gravity determination. By interviewing experts, observing practical exercises, and studying professional literature, it is possible to identify thought patterns and useful insight on center of gravity application. Logically sequenced, these thought patterns and ideas can prompt users to consider relevant factors in the strategic and theater environments and make their center of gravity selections more appropriate and consistent. The same systematic approach can also help users better apply their selections to warplanning and the planning of supporting campaigns. In Chapter Four, the thesis presents one methodology in detail.

The current chapter provides topic background information and basic definitions. It discusses the status of the military's understanding of and ability to apply center of gravity. It introduces the research approach and lists pertinent research questions. Additionally, Chapter One discusses some of the difficulties inherent in any study on center of gravity. It explains the topic limitations and delimitations and outlines the importance of both the center of gravity concept and this research. Chapter One is not intended to stand alone as an introduction to center of gravity theory. In order to provide an efficient introduction to the thesis, many issues highlighted in Chapter One are resolved in later chapters.

History is filled with examples of tactical level units performing brilliantly yet failing to achieve any meaningful operational or strategic objectives. The first three years of World War I on the Western Front constitute a stark example. More recently, the American experience in the Vietnam War yielded the same frustration and caused the U.S. military to do much soul-searching. Military professionals sought to understand what went wrong and how America could avoid similar failures in the future. One missing element in the Vietnam War and in other wasteful military exertions was operational art, which links tactical combat success to strategic success in order to ensure the attainment of strategic objectives.² During the post-Vietnam period of reflection, doctrine writers and military analysts rediscovered the relevance of operational design concepts originally espoused by Carl von Clausewitz and other great military theorists.

In On War, Clausewitz introduced the concept "center of gravity," defining it as "the hub of all power and movement, on which everything depends."³ Clausewitz argued that the enemy center of gravity is "the point against which all our energies should be directed."⁴ In his book On Strategy: A Critical Analysis of the Vietnam War, Colonel Harry Summers argued that the United States failed to achieve its political objectives in Vietnam because it failed to apply Clausewitz's "center of gravity" principle as well as the adversary applied it.⁵ In 1986, the U.S. Army incorporated operational art and design principles into its capstone doctrinal manual, Field Manual (FM) 100-5, Operations. In addition, an appendix devoted exclusively to key concepts of operational design underscored the center

of gravity concept's dominant role in operational art by describing it as the "key to all operational design."⁶ Since then, center of gravity has become an important part of the military lexicon and campaign planning. Today, Joint Publication 0-1, Basic National Defense Doctrine, defines center of gravity as "that characteristic, capability, or locality from which a military force, nation, or alliance derives its freedom of action, physical strength, or will to fight."⁷ Joint Publication 1-0, Joint Warfare of the U.S. Armed Forces, underscores the concept's importance to the joint community, saying, "Finding and attacking enemy centers of gravity is a singularly important concept."⁸

While military doctrine writers agree that center of gravity determination is important, there is an alarming lack of agreement regarding what center of gravity means and how to use it. Air Force Lieutenant Colonel John Saxman, a 1992 graduate of the School for Advanced Military Studies, depicted the problem this way:

Obviously a concept that is considered to be so important should be clearly understood by everyone in the military. Unfortunately, this is not the case . . . even when a group of people agree on a common conceptual definition (of center of gravity), when the concept is applied to a specific situation they often identify remarkably different enemy characteristics as the center of gravity. This raises the obvious concern that the very foundation of our campaign planning process may be flawed because it is based upon an operational concept that is yet to be unequivocally defined, clearly understood, or consensually applied.⁹

Students and practitioners misunderstand and inconsistently apply the center of gravity concept. As Saxman observes, center of gravity is a term that seems to mean "something to everyone but not the same thing to anyone."¹⁰ Doctrinal definitions of center of gravity leave many questions unanswered. Examples used to illustrate center of gravity

application are often inconsistent with the definitions provided. For instance, Joint Publication 3-0 misuses "long lines of communications"¹¹ as an example of a strategic center of gravity. While long lines of communication constitute a vulnerability and potential disadvantage, certainly they are not the "source of all power and strength." Professional articles offer diverse opinions on what center of gravity might mean but, with few exceptions, offer little in the way of a useful methodology for students and practitioners to use when applying the concept.¹²

Many students and practitioners within the Army begin center of gravity determination by referring to a generic list of traditional center of gravity candidates.¹³ Most use the same list regardless of the strategic and theater environments. They then work by process of elimination until a candidate is selected. Even Harry Summers, a retired Army Colonel and highly acclaimed strategist, exhibits this tendency. In describing U.S. failure to identify the enemy center of gravity in Vietnam, Summers begins with a menu of possible centers of gravity extracted verbatim from an oft-quoted Clausewitz passage. He then proceeds through each and describes why the United States could not or did not focus on it during the Vietnam War.¹⁴ It is doubtful that Clausewitz intended his examples of center of gravity to be an all inclusive list applicable to every conceivable situation.

Many Air Force authors contend that any decent bombing target constitutes one of many "centers" of gravity. The air operation during DESERT STORM, sometimes called the "air campaign," in which Air Force planners identified twelve strategic target sets as "centers" of

gravity, is indicative of this tendency to view strategic targets and centers of gravity as synonymous.¹⁵ Students and practitioners from the Marine Corps typically try to find an exploitable enemy vulnerability and label it the center of gravity. Regarding center of gravity, the U.S. Marine Corp's capstone manual, FMFM 1, Warfighting, says:

Applying the term to modern warfare, we must make it clear that by the enemy's center of gravity we do not mean a source of strength but rather a critical vulnerability.¹⁶

Meanwhile, the Navy is just now beginning to enter the doctrinal debate. In the 1994 Naval Doctrine Publication 1, Naval Warfare, the Navy advocates reaching centers of gravity via weaknesses and vulnerabilities rather than via decisive points.¹⁷ Not surprisingly, the Navy offers "lengthy resupply lines" as an example of a center of gravity.¹⁸

As haphazard as the approach to enemy center of gravity determination may appear, most approach friendly center of gravity determination with even less rigor. Most students and many politicians fail to appreciate dynamic linkages between friendly and enemy strategic centers of gravity, the relative interests involved, and the ability to sustain respective bases of strength. The recent U.S. experience in Somalia is illustrative. Following the escalation of goals after UNISOM II, American will, fueled by only peripheral national interests, was pitted against the chaos caused by independent clan power. By consciously or unconsciously choosing a strategic option which forced clan leaders into a fight for survival, the United States created a dangerously asymmetrical situation. In a scenario in which survival and vital interests were not at stake, a key U.S. vulnerability, aversion to casualties, provided an indirect means of attacking our strategic center

of gravity. With no survival or vital interests at stake, we could not protect and sustain popular and political support. Meanwhile, Mohamed Farah Aideed's desire for independent power could be sustained indefinitely (if the U.S. failed to apprehend him) because he was motivated by survival interests.

Students are sometimes oblivious to, or choose to assume away circumstances that could potentially cause a center of gravity to change. For example, hypothetical exercises involving North Korea often assume away any potential for Chinese intervention rather than consciously wrestle with how to keep that potential source of power and strength at bay via economic and diplomatic means. Planners sometimes fail to use selected enemy and friendly center of gravity to focus war plans and campaign plans. For example, time-phased force deployment lists (TPFDLs) do not always reflect prioritization of assets needed to protect the friendly operational center of gravity. Similarly, many plans exhaust combat power against geographical objectives which have no relevance to the determined enemy operational or strategic center of gravity.

But some military professionals can apply the concept well. They are recognized by peers as being able to apply the center of gravity concept effectively. They appear to have an intuitive ability to identify the ultimate source from which a belligerent derives its political and military strength and through which it can best keep its adversary from accomplishing its aims. These professionals are confident and consistent in the way they apply the center of gravity concept and link it to other aspects of campaign planning. Their

strategic, operational, and organizational concepts logically relate to their selected friendly and enemy center of gravity. One such group of professionals, selected instructors at the U.S. Army War College, was identified for participation in this research.

When the author of this thesis began work on the Center for Strategic Leadership Center of Gravity project, the initial question was, "Could we capture any of the expert team's logic and present it for use by others?" Some observers said (and say) no, that center of gravity determination is pure art, pure intuition, pure genius. Others, though, argue that art and intuition need to be disciplined by logic and a framework if the center of gravity concept is to ever be useful, if it is ever to live up to its billing as the "foundation of campaign planning" and "key to operational design."

In 1993, the team of Colonels Lamar Tooke and William Mendel wrote:

Students and practitioners of operational art often find themselves guided by little more than intuition. While intuition certainly has its place, a modicum of logic should guide our thinking about the important relationships between the fundamental concepts of operational art and the application of the military element of power for strategic purposes.¹⁹

They also pointed out that "more important to planning than opinions about the center of gravity is a logical methodology for selecting the focal point of the campaign."²⁰ In 1988, the team of Metz and Downey had come to a similar conclusion, stating:

What needs to follow is a larger project of integrating historical case studies and present and future strategic considerations into a more general methodology for the identification and use of center of gravity at the strategic level. Only when this is done will center of gravity be transformed from an alluring Clausewitzian buzzword to a useful element in U.S. strategic planning.²¹

Tooke, Mendel, Metz, and Downey's collective challenge is a part of the inspiration for this thesis. An additional motivation is to provide a tool that can help the officer corps use the center of gravity concept to ensure that America's military operations translate into national victories, to help ensure there will be "no more Vietnams." This thesis will attempt to distill insight from various sources into a useful methodology that will assist students in focusing on relevant aspects of the strategic and theater environments and intelligently considering what they see prior to selecting and evaluating a center of gravity candidate. The initial focus of the knowledge engineering research was the search for tangible rules of thumb and inferences that, coupled with intuition, help strategists to isolate those aspects of the strategic and theater environments that are relevant to center of gravity determination. The ultimate focus of the thesis is on the discovery and articulation of a logical framework in which to embed such knowledge.

The research question for this thesis is: *Using knowledge engineering techniques, can we distill discernible thought patterns from selected strategists and professional literature to create a useful methodology for applying the center of gravity concept?*

As in any worthwhile research endeavor, the quest for truth did not immediately lead to answers; it led to the discovery of the proper questions. Initial process research led to many related theoretical questions that make the center of gravity concept contentious. The following list of questions is useful in and of itself as a guide for students and doctrine writers:

What is a center of gravity? How many levels of warfare do the center of gravity concept apply to? How many centers of gravity are permissible at each level? Who is responsible for determining them? Can they change and if so, under what condition? Does center of gravity apply at the strategic national level and to all elements of national power, or is it a strictly military concept? Does center of gravity have applicability in low intensity conflicts and in operations other than war? How does center of gravity differ among alliances, coalitions, nation states, and non-nation states? Does the concept even have utility in the new world order? How does center of gravity determination tie in with other design principles and campaign planning activities? What aspects of the strategic environment impact center of gravity determination? In what ways does a center of gravity relate to the myriad of strengths, decisive points, vulnerabilities, weaknesses, and chaos that surround it? How do you know if you selected a valid center of gravity? What are the consequences for making a wrong selection? Do limited goals affect what the center of gravity is or just the degree to which one needs to attack it? Is the strategic center of gravity related to one's desire and capability to engage it or is it a nonnegotiable force to be reckoned with? Can we reconcile the disparate interpretations of the Army, U.S. Marine Corps, and U.S. Air Force in some meaningful joint doctrine? Why do service doctrine writers offer different interpretations? Is friendly center of gravity figured out from one's own perspective, the enemy perspective, or both? What major categories of things influence successful strategic planners to look at one case differently than another?

The central research question, pertaining to center of gravity application, is a difficult one. The related research questions, largely concerning theory, are contentious; most are complicated enough to warrant separate theses. This thesis cannot, nor does it attempt to, find indisputable conclusions on all of these theoretical areas. There have been many attempts to clarify center of gravity theory. The best such efforts are described in Chapter Two. This thesis is not an exhaustive examination of theory but rather an attempt to deduce a logical process for center of gravity application based on how selected practitioners think about the concept and apply it.

To answer the thesis question, some--but not all--of the theoretical issues raised in the preceding paragraph are addressed. Emphasis falls only on those theoretical subtopics that are relevant to understanding the methodology and on subordinate rules of thumb, but only to the degree of detail necessary for understanding the logic flow. The methodology remains as generic as possible rather than prescribing a rigid formula for every specific strategic scenario. It prompts users to consider relevant aspects of the strategic and theater environment and offers insight and examples for different types of situations one might encounter. It does not attempt to mold into rules parts of the process that truly are art and intuition. Any realistic methodology leaves some room for art and intuition.

In sum, this thesis attempts to present a good methodology--not the methodology to which all must subscribe. Theoretical research includes analysis of logic and opinions, not simple mathematical facts.

Even if this thesis were to capture an expert's thoughts completely, there is no guarantee that all readers will agree with all of the ideas.

With the major difficulties described above, one might pause and ask whether such an undertaking was worthwhile. The author believes that the criticality of the topic and the potential value inherent in a research breakthrough warranted the costs and risks associated with selecting this thesis topic. Center of gravity is a profoundly important analytical tool. This thesis will argue that, carefully considered and applied, center of gravity analysis serves three principle purposes. It forces preliminary assessment of what ultimately must be done to achieve political aims. It forces an assessment of whether interests are important enough to justify the costs and risks associated with imposing our will on the center of gravity. It also is the foundation and provides the focus for campaign planning, although the realization is that there is no simple recipe for conducting campaigns. Finally, center of gravity application provides a unique set of checks and balances within the continuum of war. Any thesis that can provide new insight on such an important topic is a worthwhile endeavor.

This thesis looks at a new aspect of center of gravity: how to logically determine and test candidates under a wide range of strategic circumstances. It is also noteworthy in that it takes a different approach to the topic. While the focus of this thesis is on the findings and their political-military implications, the research method used for this project, described in more detail in Chapter Three, is significant in that it represents one of the first attempts to use artificial intelligence and knowledge engineering techniques to help

isolate and model strategic level thought processes. The author is aware that there are limits to scientific representation of art and intuition. But, as described in Chapter Three, properly applied knowledge engineering techniques have, in other domains, brought much tangible reasoning to a conscious level and helped force new levels of logical consistency and intellectual integrity. If this research approach succeeds in helping achieve logical consistency in the military's ability to apply the center of gravity concept, it may be useful for other researchers exploring strategic thought processes.

CHAPTER TWO

LITERATURE REVIEW

This chapter discusses the current state of publications on center of gravity, identifies major shortfalls, and suggests contributions this thesis makes to the professional body of knowledge. It also discusses additional sources on knowledge engineering for readers who are interested in better understanding artificial intelligence research techniques.

The classic work introducing the center of gravity concept is Clausewitz's On War. Despite publication in the early 1800s, On War provides the essential starting point for students of center of gravity determination. It is the literature's primary source on the center of gravity concept. Other works attempt to explain, clarify, expand, and apply the concept. On War provides the initial use of the center of gravity analogy, offers definitions of the term, provides examples of likely center of gravity candidates, and uses the term in different contexts.

For a variety of reasons, including the fact that Clausewitz was unable to finish his epic work and achieve the level of clarity he desired, On War is difficult to read and understand. Those portions of On War which discuss the center of gravity concept are as difficult, if not more difficult, than the rest of the book. Bernard Brodie's "A

Guide to Reading On War," accompanying the 1984 edition of On War, is an important supplement to the original work. In it Brodie cautions that, in On War, "some long sections are of purely historical value, or, as some would hold, obsolete, while others are charged with the greatest significance for contemporary times."¹ This is true with regard to Clausewitz's discussions of center of gravity and perhaps one reason On War is so diversely interpreted and selectively quoted. Today, in an era of increased international ties, more dispersed national power bases, more dispersed forces, and increased participation in operations other than war, the application of Clausewitz's ideas is even more challenging.

The term "center of gravity" is controversial by itself; many argue whether it is even an accurate translation of the idea Clausewitz was trying to convey. The English translation "center of gravity" comes from Clausewitz's use of the German words "Centra gravitatis" and "schwerpunkt" in On War. In Book Six, Clausewitz used the term "Centra gravitatis" and subsequently used "schwerpunkt" when discussing the same concept. Michael Howard and Peter Paret, editors of the 1984 translation of On War, consider the terms to be synonymous and translate both as "center of gravity."² Literally, *schwer* means heavy and *der punkt* means point or spot.³ The current German use of the word *schwerpunkt* is "point of main effort."⁴ Too rigid an emphasis on literal definitions of *schwerpunkt* and the physical analogy⁵ they imply will oversimplify a complicated concept--a concept which Clausewitz obviously considered very important. Clausewitz himself cautions the reader that

connotation has primacy over annotation in his use of *schwerpunkt*,
stating:

We want to reiterate emphatically that here, as elsewhere, our definitions are aimed only at the centers of certain concepts; we neither wish nor can give them sharp outlines.⁶

In the final chapter of Book Six of On War, Clausewitz describes the center of gravity as being found "where the mass is concentrated most densely" in a theater of operations.⁷ This quotation sits well with officers who are more comfortable focusing on an enemy's military rather than on other, less tangible elements of power. Yet to conclude that the enemy army is always the center of gravity ignores much of what Clausewitz has to say. At the end of Book Six, Clausewitz cautions the reader that his illustration of the center of gravity concept is not yet complete and that Book Eight "will describe how this idea of a center of gravity in the enemy's forces operates throughout the plan of war."⁸ He wrote, "That is where the matter properly belongs; we have merely drawn on it here [in Book Six] in order not to leave a gap in the present argument."⁹ In 1827,¹⁰ Clausewitz acknowledged inconsistencies in how he used the term *schwerpunkt* in his drafts of Books Two through Six. In a note by the author regarding his plans for revising On War, he called Book Six "only a sketch"¹¹ and indicated that he hoped to clear his mind when writing Book Eight and revise Books Two through Seven accordingly.¹² While Clausewitz died before such revisions were possible, his note makes it imperative that we consider Book Eight when trying to interpret his intent.

In Book Eight, Clausewitz illustrates the concept of *schwerpunkt* using both tangible and intangible examples of center of gravity--

sources of strength that constitute a belligerent's "hub of all power and movement, on which everything depends."¹³ While acknowledging that the "defeat and destruction of [the enemy] fighting force remains the best way to begin, and in every case will be a very significant feature of the campaign,"¹⁴ Clausewitz argues that defeat of the enemy in war can mean different things, that a center of gravity can extend beyond just the military element of power. In Chapter Four of Book Eight, he writes:

In countries subject to domestic strife, the center of gravity is generally the capital. In small countries that rely on larger ones, it is usually the army of their protector. Among alliances, it lies in the community of interest, and in popular uprisings it is the personalities of the leader and public opinion. It is against these that our energies should be directed.¹⁵

In Chapter Six of Book Eight, Clausewitz emphasizes the primacy of politics over the military in actual vice purely theoretical war, saying:

All the factors that go to make up war and determine its salient features - the strength and allies of each antagonist; the character of the peoples and their governments, and so forth, ... are these not all political, so closely connected with political activity that it is impossible to separate the two? But it is yet more vital to bear all this in mind when studying actual practice. We will then find that war does not advance relentlessly toward the absolute, as theory would demand. Being incomplete and contradictory, it cannot follow its own laws, but has to be treated as a part of some other whole, the name of which is policy.¹⁶

In Book One, the only book completed to Clausewitz's satisfaction,¹⁷ Clausewitz discusses the "paradoxical trinity" stemming from the people, the commander of the Army, and the government. He notes that a theory must "maintain a balance between these three tendencies, like an object suspended between three magnets."¹⁸

Clearly, then, the literal definition of *schwerpunkt*, strict adherence to the physical analogy implied by the term "center of gravity," and exclusive reliance on Book Six distorts Clausewitz's intent. His own cautions against mere annotation, his instructions that Book Eight was the centerpiece of his center of gravity discussion, and two of Clausewitz's central themes, that war is a continuation of politics and the notion of the paradoxical trinity, provide a more appropriate starting point when attempting to apply his concept.

The preceding paragraphs merely touch on the difficulty readers have interpreting On War and the concept of *schwerpunkt*. Such confusion has led some officers to consider the concept to be useless. One author, John House, calls for removal of the term "center of gravity" from the military lexicon.¹⁹ Yet, as the rest of this chapter will show, a great deal of literature continues to explore the concept and consider it to be very important.

With all the confusion, why do we continue to study *schwerpunkt*? In the words of Michael Inman, a 1990 graduate of the School for Advanced Military Studies (SAMS), "If we accept that Clausewitz's theories are important to the successful conduct of war, we cannot ignore the principle he considered most important in planning."²⁰ Patrick Swain, a 1993 SAMS graduate, wrote:

Some are more successful than others in reconciling the many inconsistencies in his book, but it is a tribute to his genius that we are still applying his thoughts to our own experiences and doctrine.²¹

Are Clausewitz's theories still relevant today or are we paying homage to extinct ideas? As this thesis will attempt to demonstrate, the

concept of center of gravity is important in that it can facilitate a rational decision concerning the use of force and facilitate proper focus of one's elements of power to achieve aims. A great deal of the professional literature outlined in this chapter, argues the modern relevance of *schwerpunkt*.

Harry Summer's On Strategy: A Critical Analysis of the Vietnam War illustrates how failure to apply Clausewitz's center of gravity concept as well as our adversary applied it led to the disaster our country experienced in Southeast Asia. Regarding American center of gravity determination, Summers observes:

By seeing the Viet Cong as a separate entity rather than as an instrument of North Vietnam, we chose a center of gravity which in fact did not exist. The proof that the Viet Cong guerrillas were not a center of gravity was demonstrated during TET-68 when, even though they were virtually destroyed, the war continued unabated.²²

In contrast, the Vietnamese correctly identified the U.S. strategic center of gravity. Summers explains his thoughts on North Vietnamese center of gravity application:

The center of gravity that they identified was the alliance between the United States and South Vietnam. As Clausewitz said, "If you can vanquish your enemies by defeating one of them, that defeat must be the main objective of the war. In this one enemy we strike at the center of gravity of the entire conflict."²³

When U.S. will was reduced to the point that America could no longer support South Vietnam, the South Vietnamese Army became the new center of gravity.²⁴

Dr. Andrew F. Krepinevich's book, The Army and Vietnam, provides a stimulating counterpoint to Summer's work. The two authors agree that the United States failed to properly focus on the enemy's strategic center of gravity; however, they come to fundamentally different

conclusions concerning what strategic concept our nation should have executed to achieve the political objectives. Summers contends that we should have taken the war directly against North Vietnam, the source of the war,²⁵ while Krepinevich argues that we failed to adequately tailor our force structure and operational concept to meet the realities and requirements of counterinsurgency warfare. Reading these two books one after the other offers students tremendous analysis of the Vietnam War, counterinsurgencies, and political-military decision making. These books also offer sobering insight regarding the difficulty of applying the center of gravity concept and developing an appropriate campaign plan in limited conflicts. While this thesis offers insight on applying the center of gravity concept in limited war and in operations other than war, the challenges of tailoring operational and organizational concepts in such environments are likely to remain significant.

Since the Army's renewed emphasis on operational design in the 1980s, many military professionals and analysts published essays on the center of gravity concept. Parameters and Military Review often feature articles exploring the center of gravity concept. Students from the School for Advanced Military Studies (SAMS) have published dozens of excellent theoretical monographs devoted to clarifying key concepts of operational design. While the SAMS monographs tend to focus below the strategic level, they are well written, well documented, and insightful.

Several SAMS monographs attempt to clarify the key concepts of operational design and their relationship to one another. John Kalb's 1987 paper, "A Foundation for Operational Planning: The Concepts of Center of Gravity, Decisive Point, and the Culminating Point" attempts

to clarify the linkage between concepts and their importance to successful campaign planning. Edward Filiberti's 1988 monograph "Developing a Theory for Dynamic Campaign Planning" is a particularly interesting discussion of the nature of war and how key concepts of operational design fit into the means, ways, and ends of war. David Fastabend's 1988 paper "A Theory of Conflict and Operational Art" discusses the theoretical relationship of conflict, war, and operational art. Walter Vanderbeeks's "The Decisive Point: The Key to Victory," also submitted in 1988, provides a discussion of the distinction and interaction between the operational center of gravity and decisive points. Vanderbeek also offers a method for identifying and exploiting enemy decisive points.

John House's "Do Doctrinal Buzzwords Obscure the Meaning of Operational Art?" submitted in 1989, depicts the confusion caused by the myriad interpretations of center of gravity and other concepts. House goes as far as to suggest removal of the term "center of gravity" from the military lexicon. One of the most innovative and entertaining monographs on center of gravity is Charles Viale's 1988 effort entitled "'A Conversation at the Club': Another Analysis of the Concept of Center of Gravity." In it Viale offers a detached view of disparate interpretations on center of gravity as overheard in a hypothetical barroom conversation between officers.

Some SAMS papers focus on center of gravity application in low intensity environments. Mark Hertling's 1988 monograph "Insights Garnered and Gained: Military Theory and Operation Peace for Galilee" illustrates the problems of neutralizing an amorphous center of gravity

in a guerilla warfare environment. Melvin Richmond's "Communist Insurgencies and the Relevance of Center of Gravity and Decisive Points," also published in 1988, focuses on operational center of gravity analysis when dealing with communist insurgencies. Thomas Mitchell's 1990 monograph, "'Fighting' at the Lower End: Applying Operational Art to Security Assistance," discusses the application of operational art to security assistance efforts in the post-Cold War era. Michael DeMayo's "Counternarcotics Campaign Planning - A Basis for Success or a Malaise for the Military?" published in 1992, offers an interesting analysis of the misapplication of the center of gravity concept in the American anti-drug effort.

Myron Griswold's 1986 paper "Considerations in Identifying and Attacking the Enemy's Operational Center of Gravity" uses two World War II operations, CRUSADER and BASTARD HUNT, to offer lessons applicable to operational center of gravity determination. Thomas Kriwanek's 1986 "The Operational Center of Gravity" is another monograph that illustrates the use of the indirect approach to neutralize or destroy an enemy's operational center of gravity. James Marks' 1990 work "In Search of the Center of Gravity: Operational Intelligence Preparation of the Battlefield" offers ideas and historical examples on how the intelligence preparation of the battlefield process related to key concepts of operational art.

Two monographs that focus on the validity of the center of gravity concept at the tactical level are Michael Inman's 1990 work "The Tactical center of Gravity: How Useful is the Concept?" and Patrick Swain's 1993 effort "The Tactical Center of Gravity: Fact or Fallacy?"

Inman illustrates the concept using the Battles of Schmidt and East Falkland and offers insight on the various interpretations of the German term *schwerpunkt*. Strain argues that a center of gravity lies beyond the reach of tactical commanders; that center of gravity is only useful at the operational and strategic levels. Strain's monograph provides an interesting discussion of German, U.S. Joint, and various U.S. service uses of the term "center of gravity."

Two monographs that focus on how the center of gravity concept relates to the decision to launch counteroffensives are James Sikes' 1988 "Kharkov and Sinai: A Study in Operational Transition" and Herbert Frandsen's 1990 "Counterblitz: Conditions for a Successful Counteroffensive." Both include several historic examples at the operational level of warfare.

Several SAMS monographs feature more detailed case studies to illustrate application of the center of gravity concept. James Zanoi's "A Smaller, More Lethal Force: Operational Art By An Outnumbered Army," prepared in 1991, looks at how the Israelis fought outnumbered and won in the 1967 and 1973 conflicts. Collin Agee's 1992 paper "Peeling the Onion: The Iraqi Center of Gravity in Desert Storm" traces the various definitions of center of gravity, its application in the Gulf War, and the relationships between various center of gravity candidates. Francis Kinney's 1990 monograph, "The Malvinas Conflict: Argentine Practice of the Operational Art" looks at the Falkland campaign from the Argentinian perspective. Scott Cottrell's 1986 paper "From Cobra to the Seine, August 1944: A Microcosm of the Operational Art," looks at operational art from the allied perspective in World War II. Oliver Lorenz's 1989

effort, "The Battle of Britain: An Analysis in Terms of Center of Gravity, Culminating Point, Fog, Friction and the Stronger Form of War" offers an analysis of how Germany attacked targets that were irrelevant to the strategic center of gravity.

As discussed in Chapter One, most American military doctrinal publications now address, in varying degrees of detail and clarity, the term center of gravity. Some military historians provide opinions on what the friendly and enemy centers of gravity might have been when writing about a given conflict. Some recent campaign plans, including the plans and after action reports for Operation DESERT STORM and most military school plans, specifically mention center of gravity, providing either further insight or confusion (depending on the source) on what the concept means and how to apply it. Just about any good book, article, or text on international relations, strategy, military history, or political or senior military autobiographies and biographies provide valuable insight on the environment in which political leaders and strategic planners must apply the center of gravity concept. Sources abound for the interested researcher and are too numerous to detail in this thesis; however, both the War College and Command and General Staff College publish excellent primers on the strategic environment as well as regional strategic appraisals. Their texts and David Jablonsky's two-part Parameters article, "Strategy and the Operational Level of War," published in 1987, provide an excellent start.

Early articles on center of gravity focus on examining the terms involved, examining disagreements concerning the meaning and applicability of each term, and offering conclusions about what a center of

gravity is and what it is not. Articles, such as Lawrence L. Izzo's 1988 Parameters article "The Center of Gravity is Not an Achilles Heel;" Steven Metz and Frederick M. Downey's 1988 Military Review work "Centers of Gravity and Strategic Planning;" James Schneider and Lawrence Izzo's 1987 Parameters piece "Clausewitz's Elusive Center of Gravity;" and Huba Wass de Czege's 1988 Army article "Clausewitz: Historical Theories Remain Sound Compass References; The Catch Is Staying On Course" offer great insight on how to avoid some common misunderstandings associated with the field of center of gravity determination. All of these articles illustrate, among other things, that the center of gravity is a strength rather than a weakness or vulnerability.

Lamar Tooke and William Mendel's 1993 Military Review work "Operational Logic: Selecting the Center of Gravity" is one of a very few articles to offer components of a methodology for center of gravity determination. Their article is valuable because it provides a useful framework for assessing the validity of center of gravity selections and illustrates the applicability of their ideas with historical examples. Several articles suggest research to identify a method to identify center of gravity candidates; however, no articles published before initiation of this project appear to articulate a comprehensive center of gravity methodology.

Many articles reflect the agenda of the author's branch of service. A typical Air Force article on center of gravity tends to digress into a treatise on airpower and targeting. Such articles, particularly those by Colonel John Warden, are not without value. Warden's contention that the enemy is a complex system is indisputable.

All senior service college curriculums include his targeting methodology, which seeks the collapse of the enemy through focus on the categories of fielded military forces, population, infrastructure, organic essentials, and leadership.⁴⁷ Unfortunately, Colonel Warden creates confusion by using the term center of gravity to describe each of the key targets in the five ring system. As Colonel Warden says, the enemy is a complex system. But it is a system of tangible and intangible strengths, weaknesses, vulnerabilities, decisive points, and targets relating to the operational and/or the strategic center of gravity. Just because something is important to bomb does not qualify it as a center of gravity candidate. Marine Corps articles advocate identification of the enemy's "key vulnerability" rather than focusing on the enemy's "hub of all power and strength." Army articles tend to focus on achieving mass against the bulk of the enemy force within a theater of operations and tend to apply the same list of candidates to disparate situations.

One refreshing exception to the service-centered syndrome is the SAMS monograph published by Air Force Lieutenant Colonel John Saxman entitled "The Center of Gravity: Does it Have Utility in Joint Doctrine and Campaign Planning?" Saxman offers a useful and dispassionate overview of the different service interpretations and doctrinal problems with center of gravity. Saxman concludes that the center of gravity concept is potentially powerful but that until it is "unequivocally defined, clearly understood, and consensually applied,"⁴⁸ it will have limited utility in campaign planning. Saxman also makes recommendations

on how to improve joint warfighting manuals so that the full potential of the concept can be realized.

A more recent trend in center of gravity scholarship is an emphasis on the chaos, non-linearity, and unpredictable nature of war. Pat Pentland's 1994 "Center of Gravity Analysis and Chaos Theory or How Societies Form, Function, and Fail" and Alan Beyerchen's 1990 International Security article "Clausewitz, Nonlinearity, and the Unpredictability of War" are two of the best works of this genre. The emphasis on realism in these works is useful. It serves as a yellow light of caution for researchers when trying to understand cause and effect relationships in the strategic arena. At the same time, these and other authors express a pessimism that suggests putting center of gravity determination in the "too hard to do" category. This thesis acknowledges the recent trend to tough-minded realism but does not surrender to the topic's difficulty.

This thesis attempts to fill a void in available center of gravity literature. Research focuses on identification of a logical process one can use to look at relevant aspects of the strategic and theater environments and determine legitimate center of gravity candidates. In anticipation of this thesis, the author, under the supervision of the U.S. Army War College's Center for Strategic Leadership, documented over fifty interviews oriented on analyzing the reasoning that selected War College strategists use when doing center of gravity analysis. This research led to several preliminary products, such as process flow diagrams, a consolidated book of quotes on various center of gravity subtopics, and a computer model that prompts users

through a scenario and helps them determine and assess center(s) of gravity. These preliminary products, developed as part of a U.S. Army War College Knowledge Engineering Group project, and the resulting feedback form the basis for much of this thesis. They also have the potential to serve, and in some places already are serving,⁴⁹ as useful sources for other researchers.

Also as part of this study, the author, with the authorization and assistance of Center for Strategic Leadership Director Colonel (Retired) Douglas B. Campbell, and Science and Technology Division Director Colonel S. Douglas Williams, helped initiate an advanced course elective entitled "Case Studies in Center of Gravity Determination" at the U.S. Army War College. One purpose of this course was to advance the level of center of gravity discussion at the War College. The other was to supplement the perspectives of the "expert team" with ideas from a select group of U.S. and international officers and to produce some detailed case studies. Each student teamed up with a member of the expert team and applied the center of gravity concept to a specific case study. The result has been a collection of case studies covering scenarios ranging from operations other than war to war and from historic to contemporary to hypothetical twenty-first century scenarios. Three of the best case studies are Tim Hoffman's "The Iran-Iraq War: Failing to Address the Center of Gravity," Gordon Moore's "Applying Clausewitz's Center of Gravity Theory in Somalia," and Charles Ware's "Case Study in Center of Gravity Determination: The Inchon Landing."

The Air War College is also offering an advanced course elective on center of gravity determination. The best literature from these

advanced courses, from the strategy departments at the Command and General Staff College and other military schools, and from think tanks such as the RAND Corporation will also prove valuable to students of strategy and operational art.

For those interested in learning more about the artificial intelligence and knowledge engineering fields discussed in Chapter Three, there is an abundance of available literature. Many books are technical and require a considerable knowledge of both computer science and human cognition. But there are also books and briefings tailored for executives and non-specialists, including military officers. For an overview of some of the ways knowledge engineering is being applied in the business world, Edward Feigenbaum, Pamela McCorduck, and H. Penny Nii's 1988 book The Rise of the Expert Company - How Visionary Companies are Using Artificial Intelligence to Achieve Higher Productivity and Profits is an excellent source. For those desiring a basic understanding of major artificial intelligence subdisciplines, the U.S. Military Academy's Artificial Intelligence - An Executive Overview is very good. Requests for copies of this text may be directed to the Office of Artificial Intelligence Analysis and Evaluation, U.S. Military Academy, West Point, New York 10996. The U.S. Army Computer Science School and the U.S. Army War College's Knowledge Engineering Group teach courses of varying scope and depth on artificial intelligence and its applicability to the military. They can provide copies of briefing slides and additional information to interested readers. The U.S. Army Artificial Intelligence Center, The Pentagon, Washington, D.C. 20310-

0200, (703) 614-6905, publishes project summaries for ongoing Army knowledge engineering efforts.

For those desiring a more rigorous introduction to artificial intelligence, Patrick Henry Winston's 1981 book Artificial Intelligence, and Marvin Minsky's 1986 book The Society of Mind are two of the literature's classic works. D. A. Waterman's 1986 book A Guide to Expert Systems, Richard V. Kelly's 1991 text Practical Knowledge Engineering, J. R. Anderson's 1980 book Cognitive Psychology and Its Implications, A. Newell and H. A. Simon's 1972 work Human Problem Solving, and Michael Ginsereh and Nils Nilssons' 1987 book Logical Foundations of Artificial Intelligence are some of the many available books that introduce the technical reader to major artificial intelligence subdisciplines. AI Magazine provides the technical reader insight on the state of the art in civilian artificial intelligence applications. The Army's quarterly AI Exchange, published by West Point's Office of Artificial Intelligence Analysis and Evaluation, serves a similar function for the military artificial intelligence community.

In summary, this chapter attempts to provide an overview of the professional literature on center of gravity. The chapter examines the origin of the center of gravity concept and the controversies surrounding its interpretation. It describes research findings pertaining to the center of gravity literature's classic work, On War. The chapter describes key books, articles, and monographs that have added value to the military's understanding of center of gravity. It examines the different military service interpretations of the center of

gravity concept and underscores relevant inconsistencies in joint and Army doctrine. It illustrates how this thesis contributes to filling a void in the literature by focusing on a methodology for center of gravity application. Finally, Chapter Two provides a brief overview of literature that pertains to this thesis' unique research approach, knowledge engineering.

CHAPTER THREE

RESEARCH DESIGN

This chapter discusses in general terms the research process used to gather information for this thesis. The discussion briefly introduces the fields of artificial intelligence and the related fields of knowledge engineering and business process modeling.

This thesis is a sequel to a larger center of gravity determination project sponsored by the U.S. Army War College's Center for Strategic Leadership. Concerned that students were graduating without a firm understanding of the center of gravity concept, Colonel (Retired) Douglas B. Campbell, Director of the Center for Strategic Leadership, ordered an effort to make the center of gravity concept easier to consistently teach, understand, and apply.¹ Major Kevin Giles, Director of the Knowledge Engineering Group, Colonel Steven D. Williams, Director of the Science and Technology Division, and Colonel (Retired) Campbell approved the author's thesis-related project research plan in September 1993. Execution began in October 1993 and continued until the author's departure to attend the Command and General Staff College in July 1994.

The basic research method used for the project and this thesis was to identify War College subject matter experts, determine what process they use when conducting center of gravity determination, and use the best insight from their processes and from professional

literature to produce a general methodology. Major General William Stofft, Commandant of the U.S. Army War College, and War College Department heads approved the participation of selected officers for the research effort.

The research for the War College project and this thesis represents the first attempt to use artificial intelligence, knowledge engineering, and business process modeling techniques to isolate the components of a strategic level thought process. In the words of Colonel S. Douglas Williams, Director of the War College's Science and Technology Division, "This project began as pure research. We had no idea how far it might go. These techniques had never been tried on strategic level problems."² The following paragraphs provide a brief overview of these techniques and how they were incorporated into the overall research methodology, project, and thesis.

Artificial Intelligence is a family of technologies that focuses on understanding human cognition and sensory abilities and, where possible, replicating these intelligent behaviors in computer programs.³ Artificial Intelligence incorporates multiple disciplines, including software engineering, cognitive science, psychology, and linguistics. Artificial intelligence technologies are applied towards two mutually dependent goals--building intelligent machines and understanding the nature of human intelligence.

Expert systems, a proven subset of artificial intelligence technologies, are computer programs that use the heuristics and experiential knowledge of one or more human experts to attain high levels of performance in a specific problem area.⁴ Expert systems are

particularly useful for problems involving interpretation, prediction, diagnosis, design, instruction, configuration, planning, monitoring, debugging, repair, and control.⁵ By capturing and sharing expert knowledge, expert systems can help improve an organization's average level of performance. By freeing human experts from the burden of explaining the same things over and over again, expert systems allow "the best and brightest" to raise knowledge to new heights. Expert systems preserve knowledge and expertise. For example, a maintenance expert system could capture and replicate a great warrant officer's techniques for fixing a specific system. Capturing knowledge from retiring experts is a potentially lucrative field. Expert systems can help organizations to apply knowledge consistently over time. This is particularly important with regard to enforcing equal opportunity. Expert systems can help make sure that identical cases are handled in the same manner throughout an organization. Expert systems provide an environment for knowledge standardization and growth. They can help enable systematic tracking of policy implementation and help decision makers swim through oceans of data. Expert systems have great potential in solving configuration problems such as determining the myriad requirements necessary to ensure joint and combined command and control interoperability. Expert systems can help avoid disasters and allow planners to experiment with branches and sequels. While expert systems are not a panacea for problem solvers and do not render human experts obsolete, they also do not get tired, have a bad day, or cloud their vision of reality with emotions.⁶

Expert systems have been very successful in both the business community and in the military, saving millions of dollars, saving time, ensuring consistency, and improving accuracy. One example of a successful commercial expert system is "XCON," a configuration expert system developed by Digital Equipment Corporation. XCON is estimated to have saved Digital over a billion dollars in its first ten years. In fact, it saved the company's strategy of offering a` la carte solutions to customers. Prior to XCON, Digital had difficulty providing cost estimates for complicated combinations of computers. They had to take the major items to a warehouse, configure them with cables and ancillary equipment, and ensure everything worked. Service representatives were not always able to duplicate the success achieved in the warehouse when fielding systems to customers. XCON, which incorporates a massive rule base of what ancillary equipment is needed to make computer equipment interoperable, enabled Digital to provide accurate price estimates in minutes. It also produces schematics for field configuration that allow service representatives to skip the warehouse phase and install customer orders with a success rate of nearly 98%.⁷

One example of a simple military expert system is "HEAT," the HAWK Engagement Assistant and Trainer. HEAT was designed to help National Guard crews handle the complex HAWK air defense guided missile system in electronic countermeasures environments. It asks the crew questions about indications on scopes and panels in the control van and, based on crew responses, guides them to look at other indicators. When enough information is available to resolve ambiguity, HEAT prescribes a target solution and advises the crew on correct actions. HEAT and

similar expert systems function in much the same way as a human expert helping a novice solve a problem over the telephone.⁸

Expert system builders are called "knowledge engineers." They use a process called knowledge acquisition to identify the rules of thumb and logical inferences which human experts use when solving specific types of problems. Knowledge engineers then perform "knowledge representation" which entails taking ideas and linkages and representing them in ways computers can understand. Knowledge representation schema include object-oriented programming, frames, and other advanced software engineering techniques. Engineers then code the knowledge into computer programs or models, usually using expert system or business process modeling shells. Finally, engineers transfer technology into the work environment so that target audiences can use the computer products without extensive training. Army knowledge engineers possess skill designator 4K. There are currently about 35 knowledge engineering groups (KEGS) in the Army. Most are in the research and development, logistics, and personnel communities, although products like HEAT demonstrate the utility KEGS could provide if positioned with battlefield operating system proponents. The army proponent for artificial intelligence is the U.S. Army Artificial Intelligence Center, The Pentagon, Washington, D.C. 20310-0200, (703) 614-6905.

Expert systems typically focus on very narrow domains because even seemingly simple problems involve a combinatorial⁹ number of rules and pattern variations. Center of gravity determination is too broad a topic to code into a true expert system without a massive investment in man-years. But knowledge acquisition, the research gathering technique

used to build expert systems, combined with a related technology known as business process modeling, appeared to be just the fresh approach needed to help achieve the needed improvement in understanding center of gravity determination.

Knowledge engineering research techniques are useful in bringing knowledge from a subconscious to a conscious level. Experts typically do not worry about how or why they know what they know. They are content to use their knowledge to accomplish higher order tasks. Like the father who must explain to his child how to keep from falling off of a bicycle, experts find it difficult to explain their methods. There usually are reasons experts do what they do. But experts combine the "steps" so fast when thinking through seemingly instinctive tasks that they are not consciously aware of what the "steps" are. Knowledge Engineering provides a means to help differentiate any tangible knowledge from that which truly is art, intuition, and genius.

While knowledge engineers cannot capture all center of gravity art, reasoning, or intuition, there are people who understand center of gravity and who have considerable experiential knowledge and useful rules of thumb. Through knowledge engineering, it is possible to raise some of their ideas from a subconscious to a conscious level and make them available for analysis, synthesis, and documentation. Business process modeling is used to see and understand the flow of messages, activities, and sub-processes in an organizational process. While coding a true center of gravity expert system was not feasible, it seemed possible to use a business process modeling tool to model any thought process derived via expert system research techniques.

There are many viable knowledge acquisition methodologies. The "KA Grid Technique" was the method of choice for this research. Developed by Digital Equipment Corporation, the KA Grid technique approaches five distinct types of tangible knowledge (layouts, stories, scripts, metaphors, and rules of thumb) with six different angles of questioning (grand tour, cataloging the categories, ascertaining the attributes, determining the interconnections, seeking advice, and cross-checking.)⁵⁹ In the words of Colonel Len Fullenkamp, Director of History in the Army War College's Department of National Security and Strategy, the technique ". . . forces intellectual integrity. It does not allow logical inconsistency to go unchallenged."⁶⁰ The technique caused another subject matter expert to quip that we should rename knowledge acquisition "knowledge inquisition." KA Grid forces researchers to reduce knowledge to its smallest tangible components. When done correctly, the method is transparent to the expert. Lines of questioning progress naturally based on expert responses to previous questions and expert actions during case studies. But over a series of interviews, using the KA Grid as one might use a checklist ensures that researchers approach specific sub-topics from as many angles as possible. General inferences and rules of thumb are either verified, reduced to several more specific rules, or disproved entirely.

Knowledge acquisition is a time intensive process. All knowledge engineering-related projects share a common difficulty in that the people who possess the most expert knowledge are almost invariably the busiest and least available. This center of gravity research faced the additional obstacle of being experimental. Knowledge engineering of

strategic thought processes had not been attempted. There was uncertainty regarding what results were possible. The decision was made early on by Colonel Williams, Director of the Science and Technology Division, and Colonel (Retired) Campbell, Director of the Center for Strategic Leadership, that it would not be suitable or feasible to engage senior leaders above the War College level until initial research led to a viable prototype methodology. Fortunately, Major General William Stofft, Commandant of the U.S. Army War College, and his department heads were concerned enough about student difficulty with the center of gravity concept to allow several of the faculty's top strategists to take part in the knowledge acquisition process.

The principle subject matter expert for the knowledge engineering research was Colonel Campbell. As director of the U.S. Army War College's Center for Strategic Leadership and as a member of the College's Advanced Warfighting Studies Faculty, Colonel Campbell was well respected for his views on the center of gravity concept. As the project sponsor, he was willing to go through enough interviews to give the project a chance for success. Others who participated in the formal individual interview sessions included Colonel Robert Coon, Director of the War College's Advanced Warfighting Studies Program; Colonel Lamar Tooke, Director of the School of Corresponding Studies and published author on the center of gravity concept; Colonel Len Fullenkamp, Director of Military History in the Department of National Security and Strategy; Dr. (Retired Army Colonel) David Jablonsky of the Department of National Security and Strategy; Colonel (Retired) Phil Mock of the Department of Military Strategy, Plans, and Operations, and Colonel S.

Douglas Williams, Director of the Science and Technology Division.

While several other people were consulted and contributed key insight and feedback, this team was the target for formal knowledge acquisition and the development of the prototype models.

Interviews were conducted individually. The sessions were iterative and carefully documented. Each session began with an opportunity for the expert to confirm, modify, or deny any inferences gleaned during the previous meeting. This helped create an environment in which the experts felt free to "think out loud." Out of the initial interviews, categories of subtopics became apparent. Quotes were compiled on the various subtopics and used to elicit feedback from other experts. Ideas, organized under their respective subtopics, were distributed to the expert team in a pamphlet entitled "An Initial Compilation of Quotes, Thoughts, and Ideas From Our Interviews." The intent of the pamphlet was to prompt further discussion and more critical examination of individual ideas and subtopics. The source of each quotation remained anonymous in order to force experts to criticize ideas without being biased by where the quotation originated. Each idea would either stand, fall, or be modified on its own merits. Over time, the skeletons of individual processes were identified. The common elements of these individual thought processes formed the basis for prototype static and dynamic process models described in Chapter Four of this thesis. Static models are posters depicting the top-level thought process derived from an expert or group of experts. Dynamic process models are interactive computer models that intelligently help guide a student through the center of gravity determination process. Group

sessions improved the prototypes and identified what issues remained contentious and why.

Further group sessions, use of group systems software, and a rigorous testing and evaluation plan would be necessary to bring the project to the next level. (These follow-on projects are the focus of Chapter Five.) But the research conducted succeeded in capturing valuable knowledge and yielded a process, described in Chapter Four, which can help improve understanding and application of the center of gravity concept.

In summary, the major steps in the execution of the research plan were part of a larger center of gravity project. Research began with project concept development, briefings of key sponsors, preparatory research and coordination, and compilation and analysis of existing literature. The Knowledge Engineering Group developed an initial static model, based on professional literature, to see where gaps in application knowledge existed. The next step was selection and solicitation of an expert team. The main part of the research was the conduct and documentation of detailed knowledge acquisition interviews using the KA Grid technique. During the interviews, research uncovered major contentious issues. The author prepared and analyzed a book of quotes on center of gravity subtopics derived from the initial phase of interviews. To complement the interviews, case studies, and reading, the author participated in faculty development workshops and relevant campaign planning seminar discussions to observe students and teachers in action doing center of gravity determination. There followed a development of static model drafts⁶¹ (sketches of thought process flows)

for the process used by several experts to determine center of gravity. The author iteratively refined static models with experts during interviews. The next phase of the project was knowledge representation (representing ideas and connections as objects, frames, and in other ways the computer understands). The next step was development of an interactive AI-based dynamic process model⁶² that simulates a synthesized center of gravity determination thought process. Work on the dynamic model continued for the duration of the project.

During the period January-March 1994, the expert team and the thesis writer conducted a center of gravity advanced course to elicit different perspectives. The ten students included a graduate of the School for Advanced Military Studies, a brigadier general from Egypt, colonels from the Philippines and Venezuela, and two Air Force colonels. Following the course, student case studies were compiled and analyzed. During the period March through June 1994, the author conducted internal testing and evaluation of the dynamic process model prototype. The model was demonstrated to a variety of visitors and members of the War College faculty and feedback was incorporated as appropriate. A partial list of outside people who saw the model includes retired Generals Crosbie Saint, Carl Vuono, and Jack Merritt; Major General Paul Cerjan of National Defense University; Brigadier General Kiszely, Deputy commandant of the British Command and Staff College; Mr. Walter Hollis; attendees at the Center for Public Policy's Peacekeeping Entrance and Exit Criteria Conference; participants in an Allied Forces Central Europe (AFCENT) campaign planning training exercise; members of the Air Command and Staff College, members of the Naval (now Joint) Warfare

Analysis Center, and members of the Combat Analysis Agency. Several members of the War College faculty and a good portion of the War College Class of 1994 worked with the prototype model and provided valuable feedback. While at the Command and General Staff College, the model was shared with selected faculty members and with students from the School for Advanced Military Studies (SAMS) program. The final phase of the project and research, synthesis and publication of a methodology, is the role of this thesis.

CHAPTER FOUR

ANALYSIS

This chapter provides an overview of how the research methodology described in Chapter Three led to identification of a logical process for sifting through a political-military scenario and applying the center of gravity concept. It then describes the process.

When the center of gravity project began in October of 1993, the prospects for success were far from certain. The attempts to use artificial intelligence techniques were experimental. Some businesses use similar techniques to build dynamic process models of *business* processes. But this research was the first known attempt to use knowledge engineering techniques to capture a complicated, strategic level *thought* process. As is typical of a thorough knowledge engineering effort, initial interviews offered little prospects for capturing a comprehensive methodology. They revealed many interesting ideas but little connectivity between them. Discussion of historical and hypothetical scenarios helped test the versatility of ideas. For example, some rules of thumb proved applicable for certain intensity levels, types of governments, and so forth, but not for others. This realization led to the documentation of more specific ideas on center of gravity subtopics and cases.

As with experts in many fields, each member of the expert team was initially unable to articulate any sort of method to his center of gravity application. They were quickly able to identify centers of gravity in case studies and explain their selections. But they had never devoted time to understanding the specifics of the mental thought process they had used. But after each expert had been subjected to several interviews geared at reverse engineering case studies, patterns began to emerge that made it possible to start seeing the beginnings of a process flow. When this happened, the author developed static models of individual thought processes and iteratively improved them with the experts over the next several interviews. Each expert and the author used their individual static model when attempting case studies of diverse scenarios. Notations were made where the model was effective and where it broke down or became unclear.

As with the initial compilation of ideas, the author did not share static models with other experts until late in the process. As with the theoretical subtopics, expert static models revealed several common elements. They all had some way of sorting through the strategic environment and separating center of gravity candidates from mere strengths, decisive points, objectives, targets, vulnerabilities, and weaknesses. Based on their rules of thumb, they then selected a strategic center of gravity that best met their version of the Mendel-Tooke validity test.¹ They then considered suitable feasible, and acceptable approaches to the strategic center of gravity using national elements of power. In scenarios requiring a military campaign or campaigns, experts analyzed enemy forces and isolated and tested an

operational center of gravity candidate. When immediate action to neutralize the enemy operational center of gravity was not viable, they looked at decisive points and vulnerabilities that might put them in position to impose their will on the operational and strategic centers of gravity. The experts all had some process for assessing shifts or changes in the center of gravity. All had a method for identifying friendly centers of gravity. And all experts had a mental framework for using center of gravity selections to focus their hypothetical war efforts and campaigns. Each expert had or developed an appreciation for the dynamics between friendly and enemy centers of gravity and relative interests. While there was a difference of opinion on some specific ideas, the common elements became the major subprocesses for the automated model, the U.S. Army War College "Center of Gravity Determination Assistant."

Based on these common themes, the ideas garnered from interviews and professional literature, and using Colonel Campbell's thought process as the foundation, the thesis author developed an initial dynamic model. The dynamic model was produced using an artificial intelligence-based business process modeling tool called DECMoDel.² The author worked with the experts to iteratively refine the dynamic process model until the principal expert, Colonel Campbell, felt it accurately reflected the essential elements of his thought process as well as a synthesis of the best ideas from the other static models. The model was then demonstrated to others in order to obtain feedback and make further refinements.

For those receiving an original copy of this thesis, a poster is enclosed to supplement the discussion in this chapter. The chart, prepared by Major Kevin Giles of the U.S. Army War College Knowledge Engineering Group, was derived directly from the top-level process objects in this author's automated model. The poster does not contain the detailed explanation capabilities of the automated tool; however, discussions in this chapter provide similar detail. For readers receiving this document via the Defense Technical Information Center (DTIC) or other second hand source, Chapter Four subtitles reflect major elements of the center of gravity thought process and the chapter content provides detailed discussions. Readers may send inquiries concerning obtaining a copy of the poster and/or a runtime version of the actual dynamic model, which works on Windows-based 486 computers, to the U.S. Army War College Center for Strategic Leadership, Carlisle, Pennsylvania, 10713.

The paragraphs that follow include highlights of some of the theoretical issues examined during this research. They do not represent the full scope of theoretical research inherent in the project and do not pretend to be an all-inclusive discussion of center of gravity theory. The principle goal of the research was to attempt to decipher a logical methodology for center of gravity determination. The purpose of the remainder of this chapter is to walk the reader through one such methodology.

Process Introduction

The subtitles in this chapter are derived from the top-level process objects in this author's automated model. The intent of the model is to prompt users to answer questions about process objects. Based on initial responses, the automated model moves as needed to more detailed questions about subtopics. The automated model provides expert insight for the user to consider; however, it does not prescribe answers. It is meant to excite but not replace judgment. Provided with logical inputs, the model helps lead users to consider questions and apply center of gravity determination logically. The remainder of this chapter discusses a, not the, center of gravity determination process.

Cautions

When using this model, the reader should not confine his or her thinking to that of any one specific military role or perspective. This is a holistic, unconstrained thought process model. It is designed to help users think about center of gravity starting at an international/strategic national/non-nation state leadership level. The model does not initially focus exclusively on the military element of power. Using the American paradigm as an example, one could use the strategic portion of the model to posit elements the Chairman of the Joint Chiefs of Staff or Secretary of Defense might consider when giving advice to the President prior to and after a decision committing the military element of power. One can use subsequent portions of the model to help develop a theater strategy and perform operational center of gravity determination.

This model is *not* an attempt to recite existing doctrine, prescribe new doctrine, or replace current contributions to the field. Center of gravity is a contentious topic and this tool does not purport to be the final word. It represents a vehicle for raising the level of thought and discussion about a critical concept.

This concept and model are easier to apply to conventional conflict scenarios than to limited war and military operations other than war (MOOTW). The model includes discussions on center of gravity determination and application in certain MOOTW situations featuring non-state actors such as clans, cartels, and businesses. It does not represent all the ideas on OOTW derived from the War College center of gravity project and is only a beginning towards understanding center of gravity application in such diverse and complicated situations.

The model and text both use the word "decisive." The reader is cautioned to understand that "decisive" results can be achieved in different ways, depending on the nature of the conflict and the scope of the objectives. In western military thought, decisiveness normally implies a quick road to climatic battle. Clausewitz and center of gravity theory seem to suggest such efficiency, challenging readers to "dare all to win all."³ But battles of annihilation are not the only military option. "Decisiveness," in short, simply means ensuring the conditions necessary to weaken the enemy center of gravity enough to ensure achievement of your aims.

As a final caution, both the model and this thesis include many judgments and *opinions* from top instructors at the U.S. Army War College and others who have contributed to the professional literature. The

writer is aware--and the reader is cautioned to be aware--that judgments and informed opinions do not constitute axioms. The "expert" logic is provided to help the reader look at certain things that selected experienced officers feel are important and to help the reader think about center of gravity determination and application. The reader is not expected to take every opinion as unassailable fact.

Apriori Assumptions Used in the Center of Gravity Determination Model

This school of thought for center of gravity determination, developed via iterative interviews and case studies with Colonel (Retired) Douglas B. Campbell, Director of the U.S. Army War College Center for Strategic Leadership; Colonel Robert Coon, Colonel Len Fullenkamp, Colonel (Retired) Phil Mock, Doctor (Colonel retired) David Jablonsky, Colonel Lamar Tooke, and Colonel S. Douglas Williams incorporates the following beliefs and assumptions:⁴

The strategic center of gravity is the root source of power and strength--it is never a weakness or vulnerability compared with other assets on the same side (although it may be vulnerable to a stronger adversary if not properly protected).

Center of gravity determination, if properly conducted, serves three principle purposes: It forces preliminary assessment of what ultimately must be done to achieve aims and, consequently, forces an assessment of whether interests are important enough to justify the costs and risks associated with defeating/neutralizing the center of gravity. Secondly, it is the foundation and provides the focus for campaign planning. (It does not, and is not supposed to, explicitly

tell one *how* to conduct the campaign.) Finally, center of gravity provides a unique set of checks and balances along the continuum of war. Subordinate center of gravity selections should not be imposed but should be checked to ensure that they are logically derived from the higher center of gravity selection and objectives.⁵

The center of gravity is generally well protected and hard to defeat or neutralize. Yet one must successfully impose its will on it to win. Merely attacking weaknesses and vulnerabilities is attractive because it is easier;⁶ however, a nation or group will not accomplish its aims and may become embroiled in a quagmire through such improperly focused efforts.

There is one, not many, strategic center of gravity.⁷ The term "strategic center of gravity" should not to be confused with the terms "strategic target(s)," "decisive point(s)," "critical asset(s)," or "key vulnerabilities." It is wrong and counterproductive to mislabel every important part of the complex enemy system (potential targets) as somehow being "centers" of gravity.

While operational level center of gravity is heavily dependent on theater objectives, strategic center of gravity does not change as a function of theater objectives, capabilities or willingness to utilize capabilities. The enemy's source of power and strength does not change just because leaders are not willing or capable of imposing their will on it. The objectives affect how much/how one strikes at the center of gravity--not what it is.⁸

While war is very complex, nonlinear, and dynamic and is impacted by a myriad of important variables which planners must

consider,⁹ the strategic center of gravity is almost always some aspect of that which controls the state, alliance, coalition, or group and the operational center of gravity is almost invariably some aspect of the military force(s).¹⁰ The strategic center of gravity is almost always found at the strategic *national* level while the operational center of gravity is almost always found at the strategic *theater* level. While the center of gravity determination thought process can arguably be applied at the tactical level, the focus in tactics can better be described using the terms "objectives," "decisive points," or "key vulnerabilities."¹¹

The Basic Process

Distilled to its simplest form, the basic thought process for center of gravity application involves the following steps:

1. Consider relevant aspects of the strategic and theater environments.
2. Identify and test a logical strategic center of gravity candidate focusing on that which controls the enemy alliance or coalition, state, or group and propels it to pursue its aims.
3. Consider suitable, feasible, and acceptable approaches.
4. Identify and test a logical operational center of gravity candidate focusing on that aspect of the forces that most stands in your way/is most essential to enemy success.
5. Consider relevant decisive points and key vulnerabilities.
6. Evaluate things that might cause the center of gravity to shift or change.

7. Assess friendly strategic and operational centers of gravity.

8. Use center of gravity selections to focus war efforts and campaign plans.

Scenario Starting Point

The starting point for this model's "crisis action" scenario is triggered when something happens in the world and/or domestic situation; existing interests and relationships; the media reaction, public response, congressional reaction; initial National Security Council, State Department, Department of Defense and other advice; and other factors prompt the president to consider using national elements of power to solve a problem or achieve a set of goals. The same process lends itself to application during deliberate planning.

Consider Relevant Aspects of the Strategic and Theater Environments

Appendix 1 contains a checklist of some of the many things one must look at to understand the enemy. Using this checklist, one is prompted to identify strengths, weaknesses, vulnerabilities, and asymmetrical capabilities from all of the adversary's elements of power. Later in campaign planning, some of the strengths and vulnerabilities may qualify as decisive points and key vulnerabilities relevant to the determined strategic and operational centers of gravity. All of the items on the list, and many others that are omitted, are important to warplanning. Detailed discussion of each item in Appendix 1 is beyond the scope of this thesis. The items provide insight on how best to impose one's will on the enemy center of gravity. But they are not all

relevant to what the strategic center of gravity is. The subsequent steps in this methodology attempt to replicate how experts streamline the determination process and tie their analysis of the strategic and theater environments, to include the items in Appendix 1, to center of gravity application.

Conflict Scope

You will now begin to sort through the strategic environment to isolate a valid strategic center of gravity candidate. A logical first step is to begin defining the scope of the conflict or problem. When examining the conflict scope, one must observe whether the various enemy groups being faced are logically related to one war effort or whether they constitute multiple wars. To constitute multiple wars, the enemies must be pursuing separate agendas with forces that do not act in concert and/or are separated by great distances.¹² Using this definition, Japan and Nazi Germany posed two distinct wars but Germany and Italy were both part of the same conflict in World War II. In military operations other than war (MOOTW), when assessing non-allied competing groups such as clans or cartels which are logically related to the same fundamental problem, the groups can be treated as being part of one conflict or problem set.

If truly faced with two completely unrelated sets of threats such as the allies faced when fighting wars against the Nazis and Japanese, the automated model advises the user to conduct center of gravity determination on each separately. Based in part on the relationship between the costs and risks associated with the center of

gravity and the short and long-term interests involved, the user must prioritize one conflict for the strategic offensive and one for the strategic defensive. In the words of Clausewitz:

when two almost wholly separate wars have to be fought simultaneously one of them must be treated as the main operation, calling for the bulk of the resources. Seen in this light, it is advisable to operate offensively only in this main theater and to stay on the defensive elsewhere. There an attack will only be justified if exceptional conditions should invite it.¹³

Identification of the Enemy States or Groups

The next portion of the model asks whether the foe can best be described as an alliance or coalition, a single enemy state or group, or non-allied group(s). This classification is not an easy one to make. For example, consider a threat from North Korea. Is the threat a single enemy nation state or is there an actual or implied coalition with China as a senior partner? Similarly, when the foe is a terrorist group, is it involved in an explicit or implicit coalition with a nation-state sponsor? Are there third parties supplying nuclear or other materials?

To accurately determine strategic center of gravity, one must gauge the likelihood of international cooperation based on interests, commitments and historical behavior.¹⁴ Then throughout planning and the campaign, one must monitor shifts in international circumstances which might cause a shift in the strategic center of gravity. In the case of a dominant international partner, neutralizing their strategic center of gravity (preferably before their forces are actively involved) can often be decisive. For example, a future war with North Korea begins now with diplomatic and economic efforts to ensure that China will not intervene militarily.

Non-allied groups, including military clans competing for power in Somalia, illegal economic groups like drug cartels, and legal business groups, present unique challenges. Imposing one's will on one group may "send a message" to other similar groups; however, it does not always follow that success against one leads to success against all. The nature of competition, particularly economic competition, leads other groups to compete for the opportunity to fill any void caused by the downfall of another. Colonel Lamar Tooke described the phenomenon this way: "Dealing with economic entities can be analogous to bobbing for apples. You push one down and another pops up in its place."¹⁵ Sometimes the most effective approach to impose your will on an economic entity or group of competing entities is via demand. But demand can be as slippery a target as cartel or business leadership. The demise in demand for one substance or product may spark the growth in demand for yet another substance.

Unless one can leverage some common interests and co-opt the competing groups into a coalition, each group must be considered a unique strategic entity with its own center of gravity. Sometimes successfully attacking (either directly or indirectly) the strategic center of gravity of the largest or most threatening group will help force some cohesion into other competing groups and give one the leverage to impose one's will on the remaining groups in one campaign.¹⁶

Based on this insight, the user is asked, "Which choice below best describes your foe(s)?: "Alliance or coalition," "Single state or group," or "Non-allied groups." Each scenario will be discussed in turn.

Determine the Type of Alliance or Coalition

Alliances can be actual or tacit. Alliances are generally tougher to break than coalitions because the values and relationships in an alliance are usually more deeply ingrained than in a coalition.¹⁷ Alliances usually share the additional advantage of having exercised operational plans and standard operating procedures; however, their methods and weaknesses are known up front to adversaries.¹⁸

Alliances and coalitions can be dominated by one strong member or can feature more or less equally significant contributions from many members. In a dominated coalition, the strategic center of gravity of the dominant partner often is the key for the whole coalition. But sometimes the perception of legitimacy gained by international cooperation is so important that even seemingly modest coalition contributions are essential to success. In such cases, the strategic center of gravity is best described as some combination of the strategic center of gravity of the strongest member and that of the coalition as a whole.¹⁹

Based on this advice, the user considers whether he is confronted with a dominant partner alliance or coalition or a more equal partner alliance or coalition.

Single Enemy States or Groups

When dealing with a single enemy state or group, proceed to the next subprocess: "Note the scenario timeframe."

Non-State Entities

Based on the insight provided under the heading "Identify the enemy states or groups," the user must decide which option best describes the foe: military or terrorist groups/clans, illegal economic entities such as drug cartels, legal businesses, or some other non-state threat. If possible, one should look for ways to coopt competing groups into one entity and handle splinter groups as separate entities.²⁰ Note that "handle" is not synonymous with "kill" or "destroy." For example, a nation could handle a problematic clan leader by rendering him irrelevant. In Somalia, working with cooperating clans while feeding the people better than Aideed did may have been a more appropriate approach than an aggressive military course of action. What is it about the non-nation state entities that is the crux of the problem being addressed in the scenario? What about the non-allied groups most stands in the way of achieving our aims and denying the enemy the ability to achieve theirs? The user will then proceed to further analyze the strategic situation and the controlling mechanism of the group or groups.

Worthy of contemplation is the fact that such foes can be either geographically concentrated or they can be distributed. For example, an extremist using the leverage of information age communications can rally disparate groups of disaffected people to riot or perform other subversive acts. Situations involving non-nation states, particularly those involving the laws of economics, make center of gravity determination complicated. This portion of the model is designed to prompt the user to think about the nature of the enemy groups. After

identifying the type of groups, the user proceeds to analyze other aspects of the strategic environment that will shed light on the enemy's ultimate source of strength.

Note the Scenario Timeframe

Scenario time frames are placed into three major categories delineated by periods of technological advancement. They are: Pre-industrial (before the mid-1800s), Industrial (mid-nineteenth to late-twentieth century), and Informational (mid-1980s on).²¹ Futurists Alvin and Heidi Toffler described these periods as waves of change and dubbed them first, second, and third wave respectively.²²

The main impact the time period can have on center of gravity determination has to do with the effectiveness, redundancy, and flexibility of a nation or group's communication infrastructure. In pre-industrial times, the capital may have been a valid strategic center of gravity candidate. But in more modern times it is almost inconceivable that a state would lose all control and cease to prosecute war aims solely due to the capture of its capital city.²³

In pre-industrial times, the capital was sometimes the hub of all power and strength in a nation. For example, when Napoleon captured Vienna, the Austrian emperor was forced to capitulate because virtually all political and psycho-social power was embodied in the capital and it more than anything else represented the asset whose successful protection would ensure the attainment of the Austrian aims and denial of Napoleon's.²⁴ If analyzing an historical scenario that took place in pre-industrial times, one must consider the degree to which the power of

the nation is concentrated in the capital and see if it is a valid center of gravity candidate.

Modern capitals are unquestionably important. They may, in some instances, be so important as to constitute decisive points; however, they are almost certainly not valid strategic center of gravity candidates. Imposing will on them will not necessarily, in and of itself, ensure accomplishment of strategic aims nor will it necessarily stop the enemy from pursuing theirs. Modern communications and the dispersal, recuperability, and redundancy of most functions performed in a capital logically lead to the conclusion that almost all, if not all, second or third wave enemies can continue to function and to prosecute their aims without a capital city. Seoul offers an interesting test case because it is often listed as a center of gravity in student campaign plans. If the American people and political leadership remain committed to defeating North Korea, the fall of Seoul will not, in and of itself, prevent us from pursuing our aims. Holding the citizens of Seoul nuclear hostages is a frightening example of an indirect approach, via a decisive point (Seoul) and a key vulnerability (concern for allied casualties), to neutralize a strategic center of gravity.

Ultimately, the user must ask: "If the capital falls will the state, group, or entity cease to pursue its aims and will we achieve ours?" If the answer is no, proceed to the sub-process "Check Government Type." If the answer is yes, proceed to apply the strategic center of gravity test to the capital.

Determine Type of Government

One then must determine what category of government best describes the control of the enemy, leadership of the dominant coalition/group, or principal non-allied group/clan/cartel.

The type of government or, in the case of non-state entities, control is, according to Colonel Campbell and others, usually the most significant clue regarding the strategic center of gravity.²⁵ Proper analysis should lead to the answer of the essential questions: By what means is the alliance, coalition, state, or entity really controlled? What is the root source that propels the alliance, state, or entity to pursue its objectives? What is it in an alliance, state, or entity that can terminate, if forced or persuaded, pursuit of their side's objectives?²⁶

In an alliance or coalition, that which controls the dominant partner is generally key. In a more equal partner relationship, the strategic center of gravity may need to be more broadly defined in order to pass the validity test. For example, "the will of the American people and coalition" or "the independent power of the clans" may be the most accurate description that can pass the validity test.

While there are many types of governments, this model asks the user to identify whether the foe's government or controlling force is more like a democracy, totalitarian state, or feudal state.

The choice to focus on the type of government or means of control is, for some users, overly simplistic. It is important to note that by "relevant aspects of the strategic environment" we mean those that are *directly* relevant to what the strategic center of gravity is,

not the great many things that affect how to best approach the center of gravity. Interviews identified scores of economic, psycho-social, informational, and military capabilities that are critical to understanding an enemy and its relative strengths, weaknesses, and tendencies. (See Appendix 1.) These are all indispensable parts of an estimate process and come into to play during course of action analysis. But in the opinion of Colonel Campbell and many of his colleagues, at the strategic national level, that which controls the state, alliance, or group to do what it does and has the strength to direct and sustain the effort is the center of gravity. Other things may be strengths, weaknesses, decisive points, vulnerabilities, targets, characteristics-- but not centers of gravity.

Identify the Type of Democracy

The will of the people is a dominant influence in all democracies; however, the influence is generally even more pronounced in representative-style democracies than in parliamentary type democracies. Election frequency, media access, and the relationship between the elected head of state and the majority legislative party can magnify or restrain the degree of influence.

Strategic Center of Gravity in Democracies

In conflicts or operations of any appreciable length, the strategic center of gravity in a democracy is almost invariably the will of the people.²⁷ If in a coalition or alliance dominated by a democracy, the strategic center of gravity is almost always the combination of the will of the people and the cohesion of the

coalition.²⁸ The type of democracy and mitigating factors address the relative degree to which attacking will can be decisive.²⁹ If a democratic people's will supports, or can be induced to support, the strategic objectives and end state, will is almost invariably the driving force, the root source of strength, that the democracy must protect. It is stronger than anything else in the democracy. If not properly protected, its strength can be eroded to the point that the democracy can no longer prosecute its war aims. This can occur even before military forces can be committed. If the will of the people is weak, it must be made strong in order for the democracy to prosecute and achieve its goals--unless the anticipated duration of the conflict is so short that public support is not needed to fuel the political desire for action.

This rule of thumb must be applied with an open mind. For example, we have had occasions in American history in which the will of the people influenced but did not drive the decision to intervene or withdraw commitments of national elements of power. Leadership personality can be a major force. Colonel (Retired) Phil Mock observed:

If the leader is a myth; more than just an elected official; forceful; effectively articulates a clear ideology; is respected; and possesses power beyond that normally associated with the system's leader, that leader is a candidate for inclusion in the identified strategic center of gravity.³⁰

In quick, decisive actions such as U.S. intervention in Grenada and Panama, the will of the people may not be the only aspect of the strategic center of gravity. The personality of the leader and his inner circle of advisors initiated and sustained the call to military action.

Colonel Robert Coon raised the notion that in more lengthy, high profile deployments, America must cultivate the support of Congress and that doing so is not always merely a function of cultivating the will of the people. The narrow margin of approval for Operation DESERT STORM was not reflective of the overwhelming support of the American people yet could have hindered President Bush's ability to command the military to take decisive actions.³¹ But note that in each of the above cases where the will of a democracy's people did not drive decisions, anticipation of public response was still a major factor in decision making.³² As a general rule, experts agreed with the words of Colonel Lamar Tooke:

In a democracy, the capital or leader are not likely to be the strategic center of gravity because a democracy's leadership is more dispersed and because destroying the capital or leader would probably bolster the nation's cohesion rather than hurt it.³³

Determine the Type of Totalitarianism

If confronted with a totalitarian state or group, ascertain whether the enemy control is best described as a military dictatorship or some other form of police state.

Strategic Center of Gravity in Police States

If the leader and his policies are *irreplaceable*, the leader of the police state is probably the strategic center of gravity. If it is uncertain whether or not his aims would be pursued without him, the description of the strategic center of gravity must include his immediate circle that most provides him the means to control the direction of the state or group.³⁴ For example, it is not entirely

certain that, had we killed Adolf Hitler early in World War II, Hermann Goering or some other Nazi leader would not have enthusiastically tried to become the next "Fuhrer" and continue the conflict. Therefore, "Hitler and the immediate leadership of the Nazi party" is a better strategic center of gravity candidate than just "Hitler."

Strategic Center of Gravity in Military Dictatorships

If the military is the key to the leader's control of the government, the strategic center of gravity is possibly the connection between the leader and his military.³⁵ If not it is the leader and those immediately essential to the control of the state or non-state entity. For the dictator alone to be a valid center of gravity selection, you must be sure that he or she cannot be replaced with some other tyrant who will attempt to prosecute their aims.³⁶

Leadership

Based on the degree of power the foe's system concentrates in the leader, the leader should be evaluated as a possible strategic center of gravity candidate. If the type of government enables the leader to drive the state without any restraint and the personality of the leader is such that he alone can, more than anything else the state/entity possesses, make the difference between strategic success or failure and the leader is irreplaceable, then the will of the leader is the strategic center of gravity. This can be the case in a feudal state where the leader is a "God-King" but almost certainly could not be the case in a democracy.

Identify the Strategic Center of Gravity

Having analyzed those aspects of the enemy which are the driving force for the control of the enemy state, alliance, or threat's will, senior military leaders and the national leadership can now determine the most likely strategic center of gravity candidate and apply a test to assess its validity. Note that later on in the process, and throughout war and campaign planning, it is necessary to reevaluate the selected strategic center of gravity because it can change. Shifts in the center of gravity will be addressed farther on in the model.

Strategic Center of Gravity Validity Test

The preceding questions and associated insights should have forced you to consider that which ultimately controls the destiny of the alliance, state or group and select it as your strategic center of gravity candidate. The strategic center of gravity is now assessed for validity using three³⁷ tests: Will imposing our will on this center of gravity candidate *decisively* cause a "cascading deteriorating effect," prevent our foe(s) from achieving their aim(s), and enable us to achieve our aim(s)?

If the candidate best meets all of these tests it should become the overall focus of the war effort and campaigning.

The Dynamics Between Relative Interests, Objectives, and the Strategic Center of Gravity

Note that if an alliance, state, or entity's interests are not important enough to make it worth doing whatever is necessary to impose your will against the center of gravity, then it should consider

reducing goals to the point that less costly action against the center of gravity can achieve a decision.³⁸ If interests, aims, and the cost of decisive action against the center of gravity (necessary to achieve aims) cannot be brought into balance, the use of the military element of power should be carefully reconsidered.³⁹ When assessing the costs and risks associated with acting to impose one's will on the strategic center of gravity one must consider, amongst other things, any gross disparities in interest levels between combatants.⁴⁰ Any time a nation or coalition plans to enter a conflict for peripheral interests and, by doing so, will put its foe in a survival situation, the endeavor needs even more careful scrutiny. One must also consider whether the friendly strategic center of gravity that propels the friendly state, coalition, or groups to act can be protected and sustained long enough take the often long, patient road which may be required. This is particularly vital when considering entrance into operations other than war (OOTW) and entertaining goals which require any sort of nation building phase.

Check Nature of Conflict

Having identified, tested, and confirmed a valid strategic center of gravity, we begin the process of using it to focus our national elements of power and military campaigns. The next major step in the process is to analyze the suitability, feasibility, and acceptability of acting immediately and decisively against the strategic center of gravity. It is important to note that even though the strategic center of gravity has become our focus, it is not necessarily a target. Normally, the strategic center of gravity is indirectly

neutralized by the coordinated use of all elements of national power against relevant decisive points, key vulnerabilities, and use of the military to defeat, destroy, or neutralize the enemy operational center of gravity. It is necessary to begin by assessing the nature and totality of the conflict and the degree of action required to adequately neutralize, defeat, or destroy the center of gravity.

Total War Versus Less Than Total War

In total war, the strategic center of gravity must eventually be completely destroyed or neutralized. In less than total war, the strategic center of gravity remains the same but the degree to which one must act against it in order to achieve limited war aims changes.⁴¹ In less than total war, one may not need to overtly act against all aspects of the strategic center of gravity. Military action against a part of it, integrated with the use of other elements of national power, may be enough to adequately neutralize the effects of the whole. For example, in the Gulf War, the Iraqi strategic center of gravity was Saddam Hussein and the immediate leadership of the Ba'ath party. To accomplish U.S. and coalition war aims, it was not necessary to completely destroy the Iraqi leadership. Using the diplomatic and informational elements of power to attack their legitimacy in the international community; using the economic and diplomatic instruments to undermine the regime's domestic support; and using the military element to cut off their ability to effectively command and control the Iraqi military were indirect courses of action which allowed sufficient neutralization of the strategic center of gravity. This enabled complete and decisive

action against the Iraqi operational center of gravity, the Republican Guards. The successful action against the operational center of gravity sealed the impotence of the strategic center of gravity. Simultaneously, actions taken to heighten the will of the American people, enhance coalition cohesion, keep Israel out and, by securing basing rights in Turkey, keeping Iraq looking in two directions, positively affected the relationship between the friendly and enemy center of gravity. Had the strategic center of gravity been destroyed instead of engaged in limited ways, Iraq would not have been able to continue pursuing its agenda to the degree it has; however, broader regional goals may have been adversely affected.⁴²

Assessing the Need for a Direct Attack Against the Strategic Center of Gravity

If the objectives are less than total (i.e., less than the destruction of the enemy state or group), one must assess the degree of action necessary to sufficiently neutralize the strategic center of gravity to allow aims to be accomplished.

Check Ability to Directly Engage

If one needs to directly attack the strategic center of gravity, next comes an assessment of one's ability to immediately destroy, defeat, or neutralize the strategic center of gravity to accomplish aims. Ability and desirability do not always go hand in hand. The decision concerning direct or indirect action hinges on other factors as

well, such as the interests at stake and the price immediate action will exact from the friendly center of gravity.⁴³

Check the Second and Third Order Effects of Direct Action
Against the Strategic Center of Gravity

Next one must check to gauge whether there might be undesirable second and third order effects as a result of a direct attack on the strategic center of gravity. Will direct attack lead to adverse second and third order effects that are contrary to the desired end state and long-term regional goals? This requires great judgment and an appreciation of both enemy and coalition culture and psychology. One example where strategists considered second and third order effects was the Gulf War. Some analysts second guess the Bush administration's decision to avoid an all-out effort to destroy Iraq and install a new government of U.S. choosing. Planners probably concluded that, in the long run, it would be better if non-western people forced the overthrow of Hussein. Both our enemies and coalition partners resent occasions when America oversteps its bounds in the Arab world. Such action might have been tempting in the short run but may have adversely affected U.S. status in the region for decades to come.

Assess Political Will to Directly Engage
the Strategic Center of Gravity

If a country has the ability to directly attack the strategic center of gravity and there are no adverse second or third order effects associated with such action, then the next step is to consider whether the political leadership is willing to act directly against the

strategic center of gravity. The political leadership must be willing to take whatever actions goals and end state require against the strategic center of gravity. If the political leadership is not willing to act decisively, either directly or indirectly, against the enemy center of gravity, a serious reevaluation of ends, ways, means, interests, and objectives needs to take place.⁴⁴

Direct Attack/Action Becomes a Course of Action

If one has the need, capability, will, and is not prone to adverse second or third order effects that may result from direct attack/action, then direct action becomes an attractive course of action to achieve the national command authority goals and end state.⁴⁵ But one needs to dispassionately assess the direct attack because rarely can one directly and decisively get immediately at the strategic center of gravity in total war. In limited and operations other than war, constraints typically come into play.⁴⁶

If Immediate Action Against the Strategic Center of Gravity Is Neither Suitable, Feasible, or Acceptable

If it is determined that direct attack or action against the strategic center of gravity poses suitability, feasibility, and/or acceptability problems, one now must examine what operation or operations must be undertaken in order to allow for indirect approaches that will impose or enable imposition of will against the enemy strategic center of gravity.

Using Other Design Principles to Identify Paths to Overcome
the Enemy Strategic Center of Gravity

Center of gravity helps one determine whether interests are sufficient to pursue objectives and helps one understand what one must keep focused on and successfully influence in order to win. It does not, nor is it intended to, tell one how to design a campaign. Other design principles, such as lines of operation for force projection and identification of where and when campaigns may culminate are also integral parts of the estimate.⁴⁷

At this point in the center of gravity determination process, the user must pause to consider what broad sequence of operations could lead to the ability to successfully impose one's will on the enemy.

In nations such as the U.S., whose military strategy features force projection, a typical sequence of actions (following and in conjunction with less drastic flexible deterrent options using other elements of national power) is:

1. Political debate prior to deployment/pre-conflict activities⁴⁸

2. Deployment

3. Lodgement/Buildup

4. Defensive Operations

5. Offensive operations

6. Conflict Termination

7. Post-Conflict Termination and

8. Redeployment

A series of campaigns involving these or similar phases may be necessary against a more powerful foe or set of foes. World War II is a case in point. Once one identifies what broad sequence of actions can lead to the ability to impose one's will, proceed to the next step in the process: to determine the operational center of gravity that stands in your way.

Assumptions on Operational Center of Gravity

The operational center of gravity is almost invariably some aspect of the military force(s).⁴⁹ The enemy operational center of gravity is that military force, strength, or capability which most stands in the way of accomplishing your operational objectives. One must decisively impose his will on it in order to accomplish operational goals designed to establish the preconditions for successful results with the strategic center of gravity and objectives.

The friendly operational center of gravity is that aspect of the force(s) which is most imperative for one to have if one is to accomplish his objectives. It is irreplaceable; one must have it and protect it in order to be successful. Examples of an operational center of gravity can include:

1. The armed forces of a dominant alliance partner.
2. A dominant joint force/capability such as the land/air team.
3. A dominant service.
4. A dominant service capability (such as the OPTEMPO of the force or ability to employ operational or strategic reserves).

5. A dominant element within a service (such as "mechanized forces" or "the Republican Guards").

6. A dominant capability of an element within a service.

One must focus operations on the most specific candidate that is able to decisively satisfy the center of gravity validity test. The operational center of gravity can change as a function of changes in campaign phases, new forces entering the conflict and other major changes. Any change in center of gravity must, of course, be accompanied by a shift in focus.⁵⁰

Conduct a Detailed Force Assessment

Having identified operations and goals, the next step is to carefully assess what aspect of the enemy force(s) most stands in the way of accomplishing operational objectives, the enemy operational center of gravity. Which of the following is the most specific aspect of the force which, if defeated, will ensure accomplishment of operational aims?

1. Threat of intervention from a new power.
2. Dominant allied force.
3. Entire armed forces of a nation/group.
4. Dominant joint service forces/capability.
5. Dominant service.
6. Dominant service capability.
7. Dominant element within a service.
8. Dominant capability of a service element.

Operational Center of Gravity Validity Test

The element of the force(s) you selected may be a valid operational center of gravity if imposing one's will on it conclusively leads to accomplishment of one's aims and denial of the adversary's aims. One should choose the aspect of the force which most helps to achieve focus while still meeting this test.⁵¹

Assess Probable Decisiveness of Immediate Action Versus the Center of Gravity

Next check the ability, will, and need to immediately and decisively act against the selected operational center of gravity. If one can, without excessive risk to his own strategic and operational center of gravity, move directly to a climatic battle, direct action may be the best course of action. Operation JUST CAUSE provides an example of when U.S. forces were able to take such direct, simultaneous actions.⁵² Oftentimes, such as in World War II, the enemy operational center of gravity is out of reach. The Allies initially lacked sufficient resources to act directly against the Nazi army in Europe. They had to take an indirect approach through Western Africa until a time when sufficient resources for an invasion were available.⁵³ The reason the allies did not wait until they had sufficient strength to move against the Nazi Army in Europe was not as much a miscalculation of enemy center of gravity as it was an effort to sustain the friendly center of gravity, the cohesion of the alliance. American and British action was necessary to placate Russian demands for assistance.

Sometimes, depending on the relative interests and objectives, a combatant may need only to evade or outlast an opponent rather than

attack the enemy operational center of gravity. The Russians defeated Napoleon's 1812 invasion in this manner. The Russian operational center of gravity, the Russian Army, did not necessarily have to defeat or destroy the French Army in order to achieve Russia's survival aims. They had to elude superior French size, speed, and tactics. The French, on the other hand, had to destroy the Russian Army in order to impose their will on the Tsar and the Russian people. The Russians successfully avoided decisive battle until Napoleon was deep into the interior and his lines of communication were stretched to the breaking point. The result was French culmination. Given these dynamics, the fact that the Russians risked defeat of their operational center of gravity at Borodino is interesting. The Tsar and commanders only accepted battle at Borodino because they felt it necessary in order to sustain a key aspect of their strategic center of gravity, the will of the Russian people.⁵⁴ In modern times, operations other than war and limited wars often feature a similar dynamic. Weaker foes motivated by survival interests can defeat superpowers with peripheral interests simply by outlasting them in a contest of wills.

Identify Decisive Points/Vulnerabilities Which
Will Enable Decisive Action

If it is determined that it is not suitable, feasible, and/or acceptable to immediately and decisively act against the selected operational center of gravity, one must use the estimate process to identify relevant decisive points and key vulnerabilities which, if successfully pursued, will enable such action. Many candidates for

decisive points and key vulnerabilities should have been identified during the initial assessment of the strategic and theater environments.

Decisive Points and Key Vulnerabilities

Decisive points are critical forces that must be destroyed or neutralized or key terrain or localities which must be seized or controlled in order to enable defeat or neutralization of the enemy operational center of gravity. Strategic level decisive points can sometimes be less tangible. For example, in a future large peer competitor with a Singapore style authoritarianism and economy,⁵⁵ the immediate leadership of the autocracy may be the strategic center of gravity. A key strategic decisive point might be the business community that supports the leadership. The businesses and people support the authoritarian government largely because business is good. Winning an informational campaign to convince the businesses that a government's attack into a third state is bad for business is an example of one aspect of a plan to indirectly influence the strategic center of gravity via a less tangible strategic decisive point.

Successful attack against relevant vulnerabilities will weaken the enemy operational or strategic center of gravity. Irrelevant vulnerabilities should not be pursued just because they are easy targets. They should receive resources and attention only if relevant to the identified center of gravity.⁵⁶ Officers who do not study and understand the differences between a logical center of gravity candidate and decisive points will often mistake capital cities, nuclear weapons, oilfields, and the like as center of gravity candidates. While imposing

your will on such things can be important and, for certain parts of your theater strategy, decisive, such success will rarely be decisive at the strategic national level.⁵⁷

Check for Things That May Change the Center of Gravity

Having selected valid enemy strategic and operational centers of gravity, it is next essential to check for changes or potential changes in the dynamics of the strategic and operational environments which caused or might cause the center of gravity to shift.

Check for Strategic Center of Gravity Shift

The prospect of or actual entrance of new allies, coalition members, or groups may be significant enough to change the strategic center of gravity.⁵⁸ As an example, actions against North Korea must consider the prospects for Chinese involvement.

Check for Operational Center of Gravity Shift

Next examine whether your operational center of gravity selection will remain valid over time or whether the accomplishment of intermediate operational objectives and/or other changes in the operational environment will cause a shift in center of gravity. One now checks to see if anything in the intelligence estimate process has revealed changes in the operational environment that may cause the original operational center of gravity selection to be invalid. New forces entering the theater; significant changes in available technology such as weapons of mass destruction; and new aims can all render an operational center of gravity selection obsolete.⁵⁹ Planners

must continuously monitor changes in the strategic and operational environments that might impact on center of gravity determination.

Finalize Enemy Center of Gravity/Prepare
to Do Friendly Center of Gravity

The user now should have identified the strategic and operational center of gravity for the enemy or, if analyzing from a neutral perspective, for one of the two sides in the conflict. Additionally the user was prompted to consider the timing/indicators which might cause the center of gravity to change. Next comes an assessment of friendly center of gravity determination.

Friendly Center of Gravity Determination

To determine friendly center of gravity, one goes through essentially the same determination process. While it is useful to also have intelligence analysts attempt to do so from the perspective of the enemy, the commander must identify his own center of gravity from his perspective of the relevant facts.⁶⁰ The essential questions in friendly center of gravity determination are:

Strategic: What national or international asset must we have, protect, and sustain at all costs in order to achieve our strategic aims?

Operational: What aspect of our forces/the friendly alliance/coalition forces must we have at all costs in order to achieve our operational aims enroute to imposing our will on the strategic center of gravity.

If one can answer these questions unequivocally, he has identified the

friendly center of gravity. If not, one must keep them in mind as he redoes the determination process, this time analyzing the other side/friendly source of all power and strength.

Focusing Effort on the Center of Gravity

Now that the enemy and friendly center of gravity have been identified and validated and the interests, costs, and risks have been assessed, focus the campaign plan on the destruction or neutralization of the enemy center of gravity while taking measures to protect the selected friendly strategic and operational center of gravity. During the political debate prior to commitment of military force, deployment, lodgement, and defense/buildup phases, give particular emphasis to protecting the friendly center of gravity at all costs while doing what you can prudently do to pave the way for decisive action against the enemy. During offensive operations and the conflict termination phase, aggressively focus on the enemy center of gravity.

Note that if the campaign or war's duration is longer or if the costs more severe than anticipated during the political debate, the source of strength in participative types of governments can become vulnerable and change to a weakness if not properly nurtured and protected.⁶¹

Having identified the enemy and friendly strategic and operational center of gravity and checked for likely shifts, the national command authority can now make an informed decision on whether interests are worthy of pursuing goals with the military element of power. This will, in part, be hinged on an assessment of the dynamics

between the relative level of interests involved and the relative sustainability of will. On order, CINCs and operational commanders can focus campaign planning and execution.

In summary, this chapter, supplemented by the poster and the strategic and theater environment considerations in Appendix 1, provides a methodology which can be used when applying the center of gravity concept. The methodology is based on operational definitions, questions, and relevant insights derived from research with selected War College instructors and professional literature. The methodology features eight major steps. First, one must consider relevant aspects of the strategic and theater environments and separate center of gravity candidates from mere strengths, vulnerabilities, weaknesses, decisive points, and targets. Second, one must identify and test a logical strategic center of gravity candidate focusing on that which controls the enemy alliance or coalition, state, or group and propels it to pursue its aims. Third, one must consider suitable, feasible, and acceptable approaches to the strategic center of gravity. Fourth, one must identify and test a logical operational center of gravity candidate focusing on that aspect of the force(s) that most stands in the way of friendly aims/is most essential to enemy success. Fifth, one must consider relevant decisive points and key vulnerabilities which will put one in a position of advantage vis-a-vis the determined operational and strategic centers of gravity. Sixth, one must evaluate things that might cause the center of gravity to shift or change. Seventh, one must assess friendly strategic and operational centers of gravity. Finally, one must use center of gravity selections to help determine if interests

warrant the costs and risks associated with using national elements of power to engage the center of gravity and accomplish objectives.

Inherent in this judgment is an understanding of the dynamic linkages between relative interests, objectives, time, and centers of gravity.

If the situation warrants use of the military element of power, one must use the center of gravity selections to focus the war effort and supporting campaign plans. The methodology in this chapter offers useful questions and insights but does not prescribe answers. The methodology is meant to stimulate but not replace the reader's good judgment when applying the center of gravity concept.

CHAPTER FIVE

RESULTS AND FOLLOW ON RECOMMENDATIONS

The model described in Chapter Four and depicted in the poster and automated model is a start, not an end. It accomplished the project mission and answers the thesis research question. It now serves as a vehicle to stimulate further discussion and enhancements as it is examined by a wider range of officers and civilian strategists.

While some portions of the automated model prototype were still under contention when the author departed the War College to attend the Command and General Staff College, many commentators found it worthwhile, and it is being used internally at the War College to supplement center of gravity instruction. It is also being used at the Joint Warfare Analysis Center; has been requested by the British Command and Staff College for use in their curriculum; and is currently being reviewed by members of the School for Advanced Military Studies at Fort Leavenworth.

The stage is set for a future researcher or researchers to take the research and products produced for this project and thesis, analyze them, and make necessary improvements.

To add to the theoretical professional literature, one can explore the list of contentious questions raised in Chapter One. The best way to do this would be using group software such as Group Systems V or a

computer notes conference. This way, selected experts can offer their ideas efficiently, without taking turns and without the other problems inherent in group dynamics. They can comment on weaknesses in the arguments of others. Using such an approach would quickly produce a good body of knowledge pertaining to each contentious question. The same approach could be applied to refine and expand the author's "An Initial Compilation of Quotes, Thoughts, and Ideas From Our Interviews" pamphlet described in Chapter Three. This effort would eliminate ideas which cannot be defended, suggest modifications to those which are true in some cases but not others, and add ideas and subtopics to fill gaps. The result would be a thorough examination of theoretical subtopics to complement the discussion of contentious issues. These products could be used to further discussions leading to improvements in center of gravity doctrine and understanding.

The "Case Studies in Center of Gravity Determination" elective, initiated at the U.S. Army War College as part of this research, is continuing. This year, in addition to the course requirements, students are testing and providing feedback which will be considered for incorporation into the automated model. All students will be tasked to conduct center of gravity determination for a different case study and to explain their methodology and logic. These efforts, a bi-product of this research, will continue to add to the body of knowledge and contribute to the mission of making center of gravity easier to teach, understand, and apply.

The static (posters) and dynamic (automated) thought process models must now be systematically tested, evaluated, and improved with a

wider, joint audience. While the operational level of the model has been widely accepted, the strategic portion is contentious. Further refinement, particularly with respect to operations other than war (OOTW) and insurgency scenarios, is needed.¹

In conclusion, center of gravity is a difficult and contentious topic. But it is extremely important. Properly and consistently applied, the concept can help a nation make a rational decision with regard to committing elements of national power. It also helps focus war efforts and campaigns and helps ensure that strategic, operational, and tactical objectives are logically linked. Center of gravity is not a stand alone concept. Center of gravity determination relates to but does not replace other design principles and staff estimates.

This thesis used knowledge engineering techniques to raise the thought processes of individual experts to a conscious level, capture the common elements of their processes, and share a synthesized methodology with readers. This thesis validates the potential for using knowledge engineering techniques to capture strategic level thought processes. The thesis succeeds in producing a logical methodology to enable students and practitioners to more consistently apply the concept. The study finds that while war is very complex, nonlinear, and dynamic and is impacted by a myriad of important variables that planners must consider, the strategic center of gravity is usually some aspect of that which controls the state, alliance, coalition, or group and the operational center of gravity is usually some aspect of the military force(s). The strategic center of gravity is usually found at or above the strategic *national* level while the operational center of gravity is

usually found at the strategic theater level. The study also describes the dynamic linkages between relative interests, objectives, time, and centers of gravity and cautions against pursuing objectives for peripheral interests when doing so will put the enemy in a survival situation. The thesis and methodology also serve as foundations for future research.

The center of gravity determination process is a way of thinking. The model in this thesis does not tell users answers; rather, it prompts users to consistently consider relevant questions and logically tie center of gravity determination to other aspects of war planning and campaign planning. It is the author's hope that this thesis represents a step towards making the center of gravity concept one that can be more consistently understood and applied by military and government leaders.

ENDNOTES

Chapter One

1. U.S. Office of the Joint Chiefs of Staff, Joint Warfare of the US Armed Forces. JCS Joint Pub 1-0 (Washington, DC: National Defense University, 1991), 65.
2. U.S. Department of the Army, Army Field Manual 100-5, Operations. (Washington, DC: U.S. Government Printing Office, 1993), 6-2.
3. Carl von Clausewitz, On War, ed. and trans. Michael Howard and Peter Paret, 2nd ed. (Princeton, N.J.: Princeton University Press, 1984), 595-596.
4. Ibid.
5. Harry G. Summers, Jr., On Strategy: A Critical Analysis of the Vietnam War (New York, NY: Bantam Doubleday Dell Publishing Group, 1984), 177-185.
6. U.S. Department of the Army, Army Field Manual 100-5, Operations. (Washington, DC: U.S. Government Printing Office, 1986), 179.
7. JCS Joint Pub 1-0, 34.
8. Ibid.
9. John B. Saxman, "The Concept of Center of Gravity: Does It Have Utility in Joint Doctrine and Campaign Planning?" (Monograph, School for Advanced Military Studies, U.S. Army Command and General Staff College, Ft. Leavenworth, KS, 1992), 4.
10. Ibid.
11. U.S. Office of the Joint Chiefs of Staff, Doctrine for Joint Operations. JCS Joint Pub 3-0 (Washington, DC: National Defense University, 1993), III-28.
12. One exception, Colonel Lamar Tooke and Colonel Bill Mendel's article "Operational Logic: Selecting the Center of Gravity." It offers a methodology for checking to ensure that you have selected a valid center of gravity candidate. The War College monographs described in Chapter Two, produced as an assignment for our "Case Studies in Center of

Gravity Determination" Course, an elective established as part of this project, attempt to articulate a rational approach to center of gravity determination as applied to a specific case study. Most articles are devoted to theory as opposed to process or application.

13. The most commonly used list of center of gravity candidates is found on page 596 of the 1984 edition of On War. Clausewitz suggests situations when the Army, capital, army of a protector, community of interest, leadership personalities, and public opinion are good center of gravity candidates. It is doubtful that he desired this list to be all inclusive and to be applied to every situation.

14. Summers, 177-178.

15. Saxman, 29.

16. U.S. Marine Corps, FMFM 1 Warfighting. (Washington, DC: Headquarters, Department of the Marine Corps, 1989), 85.

17. U.S. Navy, Naval Doctrine Publication 1 Naval Warfare. (Washington, DC: U.S. Government Printing Office, 1994), 35-36.

18. Ibid.

19. Bill Mendel and Lamar Tooke, "Operational Logic: Selecting the Center of Gravity," Military Review 73, (June 1993), 1.

20. Ibid.

21. Frederick M. Downey and Steven Metz, "Centers of Gravity and Strategic Planning," Military Review, 55, (April 1988), 12.

Chapter Two

1. Bernard Brodie, "A Guide to Reading On War," in On War, ed. and trans. Michael Howard and Peter Paret, 2nd ed. (Princeton University Press, Princeton, N.J., 1984).

2. Knud Bartels, "The Center of Gravity," in An Anthology of Doctrinal Papers (Monograph, Department of Military Strategy, Planning and Operations, U.S. Army War College, Carlisle Barracks, PA, 1994), 13-14.

3. Patrick M. Strain, "The Tactical Center of Gravity: Fact or Fallacy?" (Monograph, School for Advanced Military Studies, U.S. Army Command and General Staff College, Ft. Leavenworth, KS, 1992), 5.

4. Ibid.

5. For a detailed discussion of where the physics definition and Clausewitz's operational definition diverge, see Saxman, 4-7.

6. Clausewitz, On War, 486.
7. Ibid., 485.
8. Ibid., 486.
9. Ibid.
10. In On War, there are two explanatory notes from the author which offer insight as to his intent. One is believed to have been written in 1827. The other was originally thought to have been written in 1830. It now appears that the "1830 note" was actually written a few months prior to the "1827 note." This knowledge is useful for scholars trying to understand the evolving thoughts of Clausewitz. For a full discussion of the timing involved, see Swain, 10-11.
11. Clausewitz, On War, 70.
12. Strain, 11.
13. Clausewitz, On War, 595-596.
14. Ibid., 596.
15. Ibid., 595-596.
16. Ibid., 605-606.
17. Ibid., 70.
18. Ibid., 89.
19. John M. House, "Do Doctrinal Buzzwords Obscure the Meaning of Operational Art?" (Monograph, School for Advanced Military Studies, U.S. Army Command and General Staff College, Ft. Leavenworth, KS, 1989), 24-27; 36.
20. Michael T. Inman, "The Tactical Center of Gravity: How Useful is the Concept?" (Monograph, School for Advanced Military Studies, U.S. Army Command and General Staff College, Ft. Leavenworth, KS, 1989), 4.
21. Swain, 40.
22. Summers, 178.
23. Ibid., 181-182.
24. Ibid., 184.
25. Ibid., 145.

26. J. A. Warden, "Strategic Warfare - The Enemy as a System." (Unpublished Draft, Air Command and Staff College, Maxwell Air Force Base, AL, 1993), 12.

27. Saxman, 60.

28. The War College uses the "Center of Gravity Determination Assistant" and related products. The Naval Warfare Analysis Center also uses the automated process model. The School for Advanced Military Studies is now using a poster derived from my static models to supplement their center of gravity discussions. The Deputy Commandant of the British Command and Staff College and the Commandant of National Defense University also expressed an interest in using the process model to supplement their center of gravity instruction.

Chapter Three

1. Derived from the proposed mission statement briefed to the War College chain of command in September 1993.

2. Steven D. Willams following my project concept briefing to Major General William Stofft, October 1993.

3. Tim Keppler, "Military Applications of Artificial Intelligence," (Unpublished lesson plan, U.S. Army War College, Carlisle Barracks, PA 1993), 6. This definition is a synthesis of definitions learned at Digital Equipment Corporation and the United States Army Computer Science School.

4. Ibid., 9.

5. Ibid., 10-20. These categories and applications were largely derived from the work of Randall Davis, "Overview of Artificial Intelligence and Knowledge-Based Systems in Business," (Cambridge, MA, Massachusetts Institute of Technology, 1991), presented at the Digital Equipment Corporation Artificial Intelligence Technology Center in September 1991.

6. Ibid.

7. Edward Feigenbaum, Pamela McCorduck, and H. Penny Nii, The Rise of the Expert Company (New York: Vintage Books, 1989), 216-232. Note: this book is an excellent source for those interested in learning about other expert systems success stories in the business community.

8. The author developed HEAT while a student at the U.S. Army Computer Science School in early 1993. HEAT was fielded to the Florida National Guard in Spring of 1993. It is an example of a low-cost expert system in the hands helping soldiers do their job. For further information on other military expert systems or where you can get knowledge engineering

support for your organization, contact the US Army Artificial Intelligence Center at The Pentagon, Washington DC 20310-0200, (703) 614-6905.

9. Combinatorial explosion is one of the major difficulties which expert system rule bases must contend with. A simple example of combinatorial explosion is the traveling salesman problem. There are 120 possible unique ways to travel between five cities. Adding a sixth city into the network raises the possible unique solutions to six times 120. In problems of strategy, there are almost an infinite number of patterns. In the words of Sun Tzu, "The notes do not exceed five, but the changes of the five notes can never be fully heard. In warfare the strategic configurations of power do not exceed the unorthodox and orthodox, but the changes of the unorthodox and orthodox can never be completely exhausted." Capturing all of them is not practical or possible. Fortunately, it is also not necessary to capture a process flow.

10. Marianne LaFrance, Guide to Knowledge Acquisition for Expert Systems. Marlboro, MA: (Digital Equipment Corporation Intelligent Systems Technology Group Artificial Intelligence Guide Series, 1986).

11. Interview with Colonel Len Fullenkamp, Department of National Security and Strategy, U.S. Army War College, November 1993.

12. Static models were produced using Harvard Graphics, Freelance Graphics, and Authorware Pro software.

13. DECModel, a business process modeling software developed by Digital Equipment Corporation, was used to code the thought process for center of gravity determination.

Chapter Four

1. Experts incorporated the basic elements of the validation process described in Colonel William Mendel and Colonel Lamar Tooke's 1993 Military Review article, "Operational Logic: Selecting the Center of Gravity." All said that imposing one's will on a valid center of gravity candidate would lead to a cascading, deteriorating effect; enable our aims; and deny the enemy their aims. But there was disagreement concerning feasibility being a criteria for center of gravity validation. Colonel Mendel and Colonel Tooke's article suggested that if one cannot get at the center of gravity, then selecting it is pointless. The consensus following the research was that the center of gravity does not change just because one is not able or willing to act against it. A nation must deal with the enemy center of gravity either directly or indirectly . . . or avoid committing the military element of power. We referred to these two schools of thought as "relative" and "fixed."

2. DECMoel is a product of Digital Equipment Corporation's Artificial Intelligence Technology Center. It is used to model the dynamics of business processes. It analyzes the activities, messages, and subprocesses and measures metrics of interest. It enables business strategists to redesign business processes and see the affects on objective metrics such as cost and time. It also makes redundancy and similar problems explicit.

3. Clausewitz, On War, 596.

4. The theoretical assumptions listed are highlights most essential to understanding Colonel Campbell's thought process. They by no means constitute all of the theoretical foundation for the process. Not all members of the expert team agree with all ideas expressed in the model or this thesis. Contentious interpretations in this chapter are the responsibility of the author and do not necessarily constitute the opinion of individual experts. The thought process does reflect a synthesis of Colonel Campbell's methodology and selected elements from other individual methods.

5. Interview with Dr. David Jablonsky, Department of National Security and Strategy, U.S. Army War College, March 1994.

6. Interview with Colonel (Retired) Douglas B. Campbell, Center for Strategic Leadership, U.S. Army War College, November 1993.

7. Ibid., October 1993.

8. Ibid. Note that this contention is central to the "fixed" school of thought. "Relativists" believe that the strategic center of gravity changes as a function of limited objectives. For example, a "fixed" approach to Operation Desert Storm would argue that Hussein and the immediate leadership of the Ba'ath Party was the strategic center of gravity even though our objectives did not make it necessary to destroy Hussein. Relativists would say that Hussein's command and control was the center of gravity since that was all we had to destroy militarily in order to isolate the Republican Guard from the command structure. "Fixed" proponents would refer to command and control as a decisive point.

9. Appendix 1 contains a partial list of these "important variables." After scores of case studies and considerable research, we believe that center of gravity at the strategic national level has to do with the rerelationship between the government, military, and people. All of the items in Appendix 1 are important and relate to how we conduct the war and campaign; however, they do not all affect what the center of gravity is.

10. Interview with Colonel (Retired) Douglas B. Campbell, Center for Strategic Leadership, U.S. Army War College, December 1993.

11. Initial interviews showed a difference of opinion on this topic. One expert considered center of gravity discussions below the strategic level to be pointless. One expert viewed center of gravity to be a way of thinking applicable to any form of competition. The general consensus was that there was a strategic national (strategic) and strategic theater (operational) center of gravity. Tactical "centers of gravity" could be better described using other terms.
12. Interview with Colonel (Retired) Douglas B. Campbell, Center for Strategic Leadership, U.S. Army War College, October 1993.
13. Carl von Clausewitz, On War, ed. and trans. Michael Howard and Peter Paret, 2nd ed. (Princeton, NJ: Princeton University Press, 1984), 623.
14. Interview with Colonel Lamar Tooke, Department of Corresponding Studies, U.S. Army War College, January 1994.
15. Ibid., December 1993.
16. Interview with Colonel (Retired) Phil Mock, Department of Military Strategy, Plans, and Operations, U.S. Army War College, December 1993.
17. Interview with Colonel Len Fullenkamp, Department of National Security and Strategy, U.S. Army War College, November 1993.
18. Interview with Colonel Lamar Tooke, Department of Corresponding Studies, U.S. Army War College, December 1993.
19. Interview with Colonel (Retired) Douglas B. Campbell, Center for Strategic Leadership, U.S. Army War College, November 1993.
20. Interview with Colonel Lamar Tooke, Department of Corresponding Studies, U.S. Army War College, November 1993.
21. Interview with Colonel (Retired) Douglas B. Campbell, Center for Strategic Leadership, U.S. Army War College, October 1993.
22. Alvin Toffler and Heidi Toffler, War and Anti-War: Survival at the Dawn of the 21st Century (New York, NY: Little, Brown, and Company, 1993), 9.
23. Interview with Colonel (Retired) Douglas B. Campbell, Center for Strategic Leadership, U.S. Army War College, October 1993.
24. Ibid., November 1993.
25. See Appendix 1 for a list of other elements of power considered important to understanding the strategic and theater environments. Note that some expert processes weeded through each item in Appendix 1 while Colonel Campbell and others noted those items only when considering

decisive points, key vulnerabilities, and logical approaches to the center of gravity. Colonel Campbell was confident that if he understood the relationship between the people, government, and the military, he could identify the enemy's fundamental source of power and strength.

26. Interview with Colonel (Retired) Douglas B. Campbell, Center for Strategic Leadership, U.S. Army War College, October 1993.

27. Interview with Colonel (Retired) Douglas B. Campbell, Center for Strategic Leadership, U.S. Army War College, September 1993.

28. Interview with Brigadier General Kiszely, British Command and Staff College, May 1994.

29. Interview with Colonel (Retired) Douglas B. Campbell, Center for Strategic Leadership, U.S. Army War College, December 1993.

30. Interview with Colonel (Retired) Phil Mock, Department of Military Strategy, Plans, and Operations, U.S. Army War College, December 1993.

31. Interview with Colonel Bob Coon, Department of Military Strategy, Plans, and Operations, U.S. Army War College, January 1994.

32. Bob Woodward, The Commanders, (New York: Pocket Star Books, 1991), 147, 262.

33. Interview with Colonel Lamar Tooke, Department of Corresponding Studies, U.S. Army War College, November 1993.

34. Interview with Colonel (Retired) Douglas B. Campbell, Center for Strategic Leadership, U.S. Army War College, October 1993.

35. Ibid, November 1993.

36. Ibid.

37. This is a modification of the test devised by Colonel William Mendel and Colonel Lamar Tooke in their 1993 Military Review article "Operational Logic: Selecting the Center of Gravity." Decisiveness was added as a criteria and feasibility was eliminated. Items A through C are from the original Mendel-Tooke test.

38. Interview with Colonel (Retired) Douglas B. Campbell, Center for Strategic Leadership, U.S. Army War College, February 1994.

39. Interview with Colonel Len Fullenkamp, Department of National Security and Strategy, U.S. Army War College, March 1994.

40. Interview with Colonel Lamar Tooke, Department of Corresponding Studies, U.S. Army War College, March 1994.

41. Interview with Colonel (Retired) Douglas B. Campbell, Center for Strategic Leadership, U.S. Army War College, January 1994. Note this idea is central to the "fixed" school of thought.
42. Interview with Colonel (Retired) Douglas B. Campbell, Center for Strategic Leadership, U.S. Army War College, April 1994.
43. Interview with Dr. David Jablonsky, Department of National Security and Strategy, U.S. Army War College, February 1994.
44. Interview with Colonel Len Fullenkamp, Department of National Security and Strategy, U.S. Army War College, January 1994.
45. Interview with Colonel (Retired) Douglas B. Campbell, Center for Strategic Leadership, U.S. Army War College, December 1993.
46. Interview with Colonel Bob Coon, Department of Military Strategy, Plans, and Operations, U.S. Army War College, January 1994.
47. Lamar Tooke, "Tying Operational Art Design Principles," (Unpublished film, U.S. Army War College, Carlisle Barracks, PA 1994).
48. Interview with Colonel Bob Coon, Department of Military Strategy, Plans, and Operations, U.S. Army War College, January 1994.
Note that there was debate concerning whether the fight to keep a democracy from entering a conflict constitutes a separate campaign or just a phase of the campaign.
49. Interview with Colonel (Retired) Douglas B. Campbell, Center for Strategic Leadership, U.S. Army War College, December 1993.
50. Interview with Colonel Lamar Tooke, Department of Corresponding Studies, U.S. Army War College, December 1993.
51. Interview with Colonel Lamar Tooke, Department of Corresponding Studies, U.S. Army War College, February 1994.
52. Interview with Colonel (Retired) Douglas B. Campbell, Center for Strategic Leadership, U.S. Army War College, January 1994.
53. Ibid., October 1993.
54. This analysis was inspired by participation in the Command and General Staff College's "Great Campaigns" elective (A698), taught by Dr. S. J. Lewis.
55. The hypothetical large peer competitor is derived from the "Revolution in Military Affairs Operational Concept Wargaming Program Large Peer Competitor - 2020 OSD/NA Asia Game #1" held at National Defense University 31 January to 2 February 1995.

56. Interview with Colonel (Retired) Douglas B. Campbell, Center for Strategic Leadership, U.S. Army War College, February 1994.

57. Interview with Colonel Lamar Tooke, Department of Corresponding Studies, U.S. Army War College, January 1994.

58. Ibid.

59. Ibid.

60. Interview with Colonel (Retired) Douglas B. Campbell, Center for Strategic Leadership, U.S. Army War College, February 1994.

61. Interview with Colonel Lamar Tooke, Department of Corresponding Studies, U.S. Army War College, November 1993.

Chapter Five

1. Much research was devoted to operations other than war. The findings were contentious and not all were deemed solid enough for incorporation into the automated model. One interesting idea was that when helping a nation or non-nation state (versus defeating them), the center of gravity might be the absence of something. Using this train of thought, the center of gravity in Somalia may have been the absence of a functioning government. The independent clans were the operational agents of the chaos. Hunger was a symptom of the overall problem, the lack of infrastructure and lack of security normally provided by a government. Maslow's hierarchy of needs was used as one tool to identify symptoms that might point toward a larger problem, the strategic center of gravity.

APPENDIX

PROPOSED LIST OF ITEMS TO CONSIDER WHEN ASSESSING THE STRATEGIC AND OPERATIONAL ENVIRONMENTS

The following are among the myriad of variables that may impact approaches to the center of gravity (but not necessarily what the center of gravity is):

1. GENERAL:

- a. Adversaries involved
- b. War aims involved
- c. Survival, vital, major interests involved
- d. Long term regional goals

2. INTERNATIONAL ENVIRONMENT:

- a. Scope of the conflict
- b. International standing, alignments of adversaries
- c. Commitments (treaties, diplomatic statements, executive agreements, etc) involved
- d. Previous international response(s) to the nation(s)/group(s) involved
- e. Actual or implied coercion
- f. Impact outside assistance will have on the success or failure of mission
- g. Nature of multiple combatant scenarios (Cooperating coalitions, alliances; competing legal/illegal economic groups, military groups)
- h. Cohesion of international partnerships

3. POLITICAL:

- a. Type of governments
- b. Personality of political leaders
- c. Strength/level of support for the governments
- d. Historical behavior of governments/parties in power
- e. Degree of reliance on outside assistance
- f. Historical instances of outside assistance
- g. Means of government control
- h. Degree to which the forms of government are valued
- i. Frequency of peaceful changes in government leadership
- j. Historical frequency of violent changes in government leadership
- k. Proximity to the next routine changes in government leadership
- l. Impact of a change in government leadership
- m. Impact of a change in government control mechanisms

- n. Predictability of political successor(s)
- o. Ability of government to function without the capital city
- p. Recuperability of government, capital
- q. Control of the press and media
- r. Stability
- s. Perceived legitimacy
- t. Independence of the judiciary
- u. Authority of religious clerics
- v. Influence of political parties, organizations, and interest groups

4. ECONOMIC/INFRASTRUCTURE:

- a. Basis of economy
- b. Degree of self-sustainability
- c. Redundancy in means of production
- d. Key industrial areas
- e. Communications infrastructure
- f. Multinational enterprises
- g. International financial position
- h. Relationship between government and business
- i. Ownership patterns
- j. Availability of education
- k. Surpluses/shortages of job skills

5. PSYCHO-SOCIAL:

- a. Will of the people to support aims
- b. Will of any legislative bodies to support aims
- c. Will of predominant state religion to support aims
- d. Dominant religious and cultural values
- e. Similarity of scenario to previous experiences
- f. Success of outcome in similar situations
- g. Degree to which people feel survival or enduring vital interests are threatened
- h. Likely reaction to direct attacks against homeland
- i. Likely response to battlefield casualties
- j. Character and nature of the media and it's relationship to the people
- k. Relationship between the people and the military
- l. Courage
- m. Degree, equity of how Maslow's hierarchy of needs are being satisfied
- n. Social groups and common factors which promote or discourage cooperation

6. MILITARY:

- a. Strategic vs. Operational orientation of forces?
- b. Historical Orientation of forces (offensive, defensive, MOOTW, etc.)
- c. Coequal or dominant service(s)?
- d. Dominant, decisive capabilities
- e. Degree of modernization
- f. Weapons of mass destruction: type, effectiveness, delivery

- g. Symmetric vs. Asymmetric relationships between combatant strengths and weaknesses (naval, air, land)
- h. Leadership
- i. Power projection capability
- j. Short/long term ability to put decisive power into theater

7. GEOGRAPHY:

- a. Are any adversaries island nations?
- b. Size, shape of theater
- c. Terrain in theater
- d. Distance between combatants, their support base
- e. Decisive points
- f. Population characteristics
- g. Mineral and energy resources

8. OTHER:

As deemed significant by the student

9. The ABSENCE of something.

* The author developed the above list for students of the U.S. Army War College Advanced Course "Case Studies in Center of Gravity Determination." Many of the ideas came from expert interviews. The majority of ideas came from interviews with Colonel Lamar Tooke.

** We asked students to use this list as a guide when analyzing the dominant characteristics of the enemy for center of gravity candidates. The resulting data supplemented the expert team's opinions concerning what aspects of the environment affect what the center of gravity is versus which aspects affect methods of influencing the center of gravity.

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